

BID DOCUMENTS: June 13, 2025

PROJECT MANUAL

VOLUME 2 OF 2: DIVISIONS 03-28

City School District of the City of New Rochelle

2023 Capital Project – Phase 2B

New Rochelle High School
Isaac E. Young Middle School

SED #66-11-00-01-0-001-031
SED #66-11-00-01-0-003-018

CSArch Project No. 188-2301.02



The design of this project conforms to applicable provisions of the New York State Uniform Fire Prevention and Building Code the New York State Energy Conservation Construction Code and the Manual of Planning Standards of the New York State Education Department, and the New York State Department of Labor Code Rule #56.

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DOCUMENT 000110 - TABLE OF CONTENTS

Volume 1

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

Introductory Information

000014	Certification Page
000110	Table of Contents
000115	Drawing Index

Procurement Requirements

001113	Advertisement for Bids
002113	Instructions to Bidders
003113	Preliminary Schedule

Procurement Forms and Supplements

004116.01	Bid Form Contract No. 11 – General Construction Work (GC-03)
004116.02	Bid Form Contract No. 12 – Mechanical Construction Work (MC-03)
004116.03	Bid Form Contract No. 13 – Electrical Construction Work (EC-03)
004313	A310 Bid Bond
004325	Substitution Request Form
004333	Proposed Equivalent List
004336	Proposed Subcontractors Form
004513	A305 Contractor's Qualification Statement
004519	Non-Collusion Affidavit
004520	Iran Divestment Act Affidavit
004543	Corporate Resolutions
004600	Sexual Harassment Written Policy & Training Certification Form

Contracting Requirements & Supplements

005216	A132 Standard Form of Agreement Between Owner and Contractor, Construction Manager as Adviser Edition
006113.13	A312 Payment Bond
006113.14	A312 Performance Bond
006114	C106 Digital Data Licensing Agreement
006273	G732 Schedule of Values
006274	G703 Schedule of Values Continuation Sheet

Closeout Forms

006519.13	G706 Contractor's Affidavit of Payment of Debts and Claims
006519.16	G706A Contractor's Affidavit of Release of Liens
006519.17	G707 Consent of Surety to Final Payment

Conditions of the Contract & Supplementary Conditions

007216	A232 General Conditions of the Contract for Construction, Construction Manager as Adviser Edition
007343	Wage Rates

Project Forms

008300	Project Forms
008310	Submittal Cover Sheet
008320	Request For Information
008325	Change In Condition
008330	Request For Shutdown
008340	Daily Report Cover
008350	Labor Rate Sheet
008370	Two-Week Look Ahead Schedule
008380	Bi-Weekly Material / Equipment Status Report
008440	Substantial Completion Request For Inspection
008450	Test Report / Inspection Log
008470	Submittal Schedule

DIVISION 01 – GENERAL REQUIREMENTS

011200	Multiple Contract Summary
011400	Work Restrictions
011410	NYSED 155.5 Uniform Safety Standards

Price and Payment Procedures

012100	Allowances
012500	Substitution Procedures
012600	Contract Modification Procedures
012900	Payment Procedures
012973	Schedule of Values

Administrative Requirements

013100	Project Management and Coordination
013150	Safety and Health
013200	Construction Progress Documentation
013233	Photographic Documentation
013300	Submittal Procedures

Quality Requirements

014000	Quality Requirements
014200	References
014533	Code-Required Special Inspections and Procedures

Temporary Facilities

015000	Temporary Facilities and Controls
--------	-----------------------------------

Product Requirements

016000	Product Requirements
--------	----------------------

Execution and Closeout requirements

017300	Execution
017329	Cutting and Patching
017413	Cleaning-Up
017700	Closeout Procedures
017823	Operation and Maintenance Data
017836	Warranties
017839	Project Record Documents
017900	Demonstration and Training
019113	General Commissioning Requirements

DIVISION 02 – EXISTING CONDITIONS

023313	Underground Utility Locator Service
024100	Demolition

Volume 2

DIVISION 03 – CONCRETE

033000	Cast-In-Place Concrete
035400	Cementitious Underlayment

DIVISION 04 – MASONRY

042000 Unit Masonry

DIVISION 05 – METALS

055000 Metal Fabrications
055133 Metal Ladders
055213 Pipe and Tube Railings

DIVISION 06 – WOOD and PLASTICS

061053 Miscellaneous Rough Carpentry
061600 Sheathing
064023 Interior Architectural Woodwork

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

072100 Thermal Insulation
075323 Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
076200 Sheet Metal Flashing and Trim
078413 Penetration Firestopping
078443 Joint Firestopping
079200 Joint Sealants
079219 Acoustical Joint Sealants

DIVISION 08 – OPENINGS

083113 Access Doors and Frames
089119 Fixed Louvers

DIVISION 09 – FINISHES

092116.23 Gypsum Board Shaft Wall Assemblies
092216 Non-Structural Metal Framing
092310 Patching Large Holes in Plaster with Plaster
092320 Patching Small Chips and Cracks in Plaster
092900 Gypsum Board
095113 Acoustical Panel Ceilings
096466 Wood Flooring
096513 Resilient Base and Accessories
096519 Resilient Tile Flooring

096613	Portland Cement Terrazzo Flooring
096816	Sheet Carpeting
099100	Painting

DIVISION 10 – SPECIALTIES

NOT USED

DIVISION 11 – EQUIPMENT

118129	Facility Fall Protection
--------	--------------------------

DIVISION 12 – FURNISHINGS

126100	Fixed Audience Seating (For Reference)
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DIVISION 13 – SPECIAL CONSTRUCTION

NOT USED

DIVISION 19 – THEATRICAL EQUIPMENT AND CONTROLS

190500	Theatrical Lighting and Controls Basic Requirements
--------	---

DIVISION 22 – PLUMBING

220500	General Plumbing Requirements
220502	Plumbing Demolition
220529	Supports and Sleeves
220553	Plumbing Identification
221613	Natural Gas Piping

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING

230500	General Mechanical Requirements
230502	Mechanical Demolition
230513	Common Motor Requirements
230515	Variable Frequency Drives
230529	Supports and Sleeves
230553	Mechanical Identification
230593	Testing, Adjusting, and Balancing
230713	Duct Insulation
230800	Commissioning of HVAC Systems

230900	Building Automation System
230993	Sequence of Operations
233113	Metal Ductwork
233300	Air Duct Accessories
233713	Registers, Grilles, and Diffusers
237433	Dedicated Outdoor-Air Units

DIVISION 26 – ELECTRICAL

260010	Basic Electrical Requirements
260050	General Materials and Methods
260500	General Electrical Requirements
260501	Electrical Materials and Equipment
260519	Low-Voltage Electrical Power Conductors and Cables
260526	Grounding and Bonding for Electrical Systems
260529	Hangers and Supports for Electrical Systems
260533	Raceways and Boxes for Electrical Systems
260544	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
260553	Identification for Electrical Systems
260921	Lighting Controls
260923	Lighting Control Devices
262416	Panelboards
262726	Wiring Devices
262816	Enclosed Switches and Circuit Breakers
265001	Lighting Fixture Schedule
265119	LED Interior Lighting
265561	Electrical Work for Theatrical Lighting
265565	Theatrical Lighting Miscellaneous Equipment
265569	Electrical Work for theatrical Audio/Video

DIVISION 27 – COMMUNICATIONS

270010	Basic Communications Requirements
270050	General Materials and Methods
271001	Telecom Cabling Systems – Pathways
275111	Existing Public Address Systems

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

280010	Basic Electronic Safety and Security Requirements
280050	General Materials and Methods
283100	Fire Detection and Alarm
284605	Existing Fire Alarm System

APPENDICES

Appendix A	TSI drawings (FOR REFERENCE)
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END OF DOCUMENT 000110

SECTION 033000 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Concrete formwork, reinforcing steel, and cast-in-place concrete.

1.2 RELATED WORK SPECIFIED ELSEWHERE

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

1.3 REFERENCES

A. American Concrete Institute (ACI) documents

1. ACI 117-10: Specifications for Tolerances in Concrete Construction and Materials
2. ACI 212.3R-10: Report on Chemical Admixtures for Concrete; Chapter 15 Permeability Reducing Admixtures
3. ACI 302.2R-06: Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
4. ACI 304.2R-96: Placing Concrete by Pumping Methods
5. ACI 305R-10: Guide for Hot Weather Concreting
6. ACI 306R-10: Guide to Cold Weather Concreting
7. ACI 308.1-11: Standard Specification for Curing Concrete
8. ACI 360R-10: Guide to Design of Slabs on Grade
9. ACI 317: Reinforced Concrete Design
10. ACI 318: Building Code Requirements for Structural Concrete

B. American Society for Testing and Materials (ASTM)

1. ASTM C 94/C 94M – 11b: Standard Specification for Ready- Mixed Concrete.
2. ASTM C 494/C 494M - 11: Standard Specification for Chemical Admixtures for Concrete.

C. New York State Department of Transportation Standard Specifications for Construction and Materials, Latest Edition.

1.4 SUBMITTALS

A. Product Data: Manufacturer's name, specifications, and installation instructions, for each item specified including:

1. Portland Cement: Brand, manufacturer's name, and material certificates
2. Fly Ash: Name, location of source, DOT test numbers and material certificates.
3. Air-entraining Admixture: Brand, manufacturer's name, and material certificates.
4. Water-reducing Admixture: Brand, manufacturer's name, and material certificates.

5. High Range Water-reducing Admixture (Superplasticizer): Brand, manufacturer's name, and material certificates.
 6. Accelerating Admixture: Brand, manufacturer's name, and material certificates.
 7. Aggregates: Name, location of source, DOT test numbers, and material certificates.
 8. Lightweight Coarse Aggregates: Brand, manufacturer's name, and material certificates.
 9. Chemical Hardener (Dustproofing): Brand and manufacturer's name, and application instructions.
 10. Chemical Curing and Anti-Spalling Compound: Brand and manufacturer's name, and application instructions.
 11. Bonding Agent (Adhesive): Brand and manufacturer's name, and preparation and application instructions.
 12. Expansion Joint Fillers: Brand, manufacturer's name, and material certificates.
 13. Waterstop: Brand and manufacturer's name, and installation instructions.
 14. Integral Water-Repellent Admixture: Brand, manufacturer name, specifications, application instructions and material certificates.
- 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. Include test results of proposed concrete proportions based on previous field experience or laboratory trial batches in accordance with ACI 301, Section 4.
 2. Pumped Concrete: Include test results of proposed design mix(es) tested under actual field conditions with the maximum horizontal run and vertical lift required for this project.
 3. 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. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork. Design and engineering of formwork are Contractor's responsibility.
- 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. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
1. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

2. 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.
 3. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- C. 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.
- D. Sealant Container Labels: Include manufacturer's name, trade name of product, kind of material, federal specification number (if applicable), expiration date (if applicable) and packaging date or batch number.
- E. Fly ash supplier shall be on the New York State Department of Transportation's current "Approved List of Suppliers of Fly Ash".
- F. Source Quality Control: The Director reserves the right to inspect and approve the following items, at his own discretion, either with his own forces or with a designated inspection agency:
1. Batching and mixing facilities and equipment.
 2. Sources of materials.
- G. ACI 301, Section 1.4 Reference standards and cited publications:
1. ASTM C 311-11a Standard Methods of Sampling and Testing Fly Ash or Natural Pozzolans For Use As A Mineral Admixture in Portland Cement Concrete.

1.6 FIELD CONDITIONS

- A. 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 average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 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 mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F 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. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
- C. Environmental Conditions:

1. Temperature: Unless otherwise approved or recommended in writing by the sealant manufacturer, do not install sealants at temperatures below 40 or above 85 degrees F.
2. Humidity and Moisture: Do not install the Work under this Section under conditions that are detrimental to the application, curing and performance of the specified materials.

D. Protection:

1. Protect all surfaces adjacent to sealants with non-staining removable tape or other approved covering to prevent soiling or staining.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.
- C. ASTM C 94/C 94M, Article 14 - Batch Ticket Information: In addition to the information required by Paragraph 14.1, also include the following:
- D. Batch Ticket shall include the following:
 1. Type and brand, and amount of cement.
 2. Weights of fine and coarse aggregates.
 3. Class and brand, and amount of fly ash (if any).

PART 2 - PRODUCTS

2.1 CONCRETE

- A. Cast-In-Place Concrete: Normal weight, air entrained concrete with a minimum compressive strength of 4,500 PSI at the end of 28 days.
 1. Design Air Content: ASTM C-260, and on the NYSDOT's current "Approved List"; 6% by volume, 1.5% +/- . Entrained air shall be provided by use of an approved air-entraining admixture.
 2. Cement: ASTM C-150 Type I or II Portland cement.
 3. Normal-Weight Aggregates: ASTM C 33, uniformly graded. Provide aggregates from a single source.
 - a. Maximum Coarse-Aggregate Size: ¾" walls. Slabs 1-1/2 inches nominal.
 - b. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement
 4. Water: Potable.
 5. Slump: Between 2 and 4 inches; except when a water-reducing admixture is used maximum slump shall be 6 inches and when a high range water reducing admixture is used maximum slump shall be 8 inches.
 6. Water-reducing Admixture: ASTM C-494 Type A and on the NYSDOT's current "Approved List".
 7. High Range Water-reducing Admixture: ASTM C-494 Type F and on the NYSDOT's current "Approved List".

8. Fly Ash: ASTM C 618, including Table 1 (except for footnote A), Class F except that loss on ignition shall not exceed 4.0 percent.

2.2 CONTROLLED LOW STRENGTH MATERIAL (CLSM) FILL

- A. Also known as Flowable Fill, Controlled Density Fill, Flowable Fill, Controlled Density Fill, Flowable Fly Ash and Fly Ash Slurry.
- B. CLSM, Hand Tool Excavatable: Provide mix with compressive strength of 100 psi or less when measured 28 days from placement. Minimum air content at time of placement shall be 20%.
- C. In the absence of one year strength data, the cementitious content shall be a minimum of 150 lbs./cy, the minimum air content shall be 20%, and fresh unit weight shall be a maximum of 115 lbs./ft³, except where specified.

2.3 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 when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- G. Concrete Sealer:
 1. Surebond/Safebond SB-7000 - clear concrete sealer for sidewalks.
 2. Specco Cure & Seal 350 – clear acrylic, copolymer, solvent-based, curing, sealing, hardening and dust proofing compound for curing and sealing concrete.
 3. Approved equivalents for non-water based penetrating type protective sealer which is on the NYSDOT Material List for concrete pavement.

2.4 FORM-FACING MATERIALS

- A. Prefabricated metal-framed plywood matched, tight fitting, stiffened to support weight of concrete.
- B. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 1. Plywood, metal, or other approved panel materials.
 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. B-B (Concrete Form), Class 1 or better; mill oiled, and edge sealed.

- C. 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. Only acceptable for footings and foundations that are not visible in the completed structure.
- D. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- E. Chamfer Strips: Wood, metal, PVC or rubber; one-inch chamfer, unless stated otherwise in Construction Documents.
- F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- G. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- H. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that leave no corrodible metal closer than 1-inch the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, leave holes no larger than 1-inch diameter in concrete surface.

2.5 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60 deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A 615 deformed bars, ASTM A 775 epoxy coated, with less than 2 percent damaged coating in each 12-inch length.
- C. Steel Bar Mats: ASTM A 184, fabricated from ASTM A 615, deformed bars, assembled with clips.
- D. Plain-Steel Wire: ASTM A 1064.
- E. Deformed-Steel Wire: ASTM A 1064.
- F. Epoxy-Coated Wire: ASTM A 884, Class A, Type 1 coated, plain-steel wire, with less than 2 percent damaged coating in each 12-inch length.
- G. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064, plain, fabricated from as-drawn steel wire into flat sheets. 6-inch x 6-inch – W2.9 x W2.9, ASTM A-185, welded wire fabric.
- H. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064, flat sheet.

2.6 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615, Grade 60 plain-steel bars, cut true to length with ends square and free of burrs.

- B. Smooth Stainless-Steel Joint Dowel Bars
- C. Epoxy-Coated Joint Dowel Bars: ASTM A 615, Grade 60 plain-steel bars, ASTM A 775 epoxy coated.
- D. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775.
- E. Zinc Repair Material: ASTM A 780.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," 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 steel wire or CRSI Class 2 stainless-steel bar supports.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.7 SEALANT

- A. Type 1B Sealant:
 - 1. For Horizontal Joints: One-part, self-leveling silicone or polyurethane sealant for traffic bearing construction; Bostik Chem-Calk 955-SL, Tremco Vulkem 45, Pecora Urexpan NR-201, Pecora 300-SL, Pecora 310-SL, Sika Sikaflex-1CSL, Dow Corning CCS.
 - 2. For Vertical Joints: One-part, non-sag silicone or polyurethane sealant; Tremco Vulkem 116, Pecora Dynatrol I, Sika Sikaflex Textured Sealant, Dow Corning CCS or CWS, Pecora 301-NS, Pecora 311-NS.

2.8 JOINT MATERIALS

- A. Closed Cell Polyethylene Foam Joint Filler: For use around penetrations. Flexible, chemical resistant, non-bleeding, non-staining, "strip-off" edge, by A.H. Harris & Sons, Inc. or approved equivalent.
- B. Fiber Expansion Joint Filler: Resilient, flexible, non-extruding joint compound composed of cellular fibers securely bonded together and uniformly saturated with asphalt, by A.H. Harris & Sons, Inc. or approved equivalent.
- C. Joint Primer/Sealer/Conditioner: As recommended by the sealant manufacturer for the particular joint surface materials and conditions.
- D. Backer Rod: Compressible rod stock or expanded, extruded polyethylene.
- E. Bond Breaker Tape: Polyethylene or other plastic tape as recommended by the sealant manufacturer; non-bonding to sealant.
- F. Cleaning Solvents: Oil free solvents as recommended by the sealant manufacturer. Do not use re-claimed solvents.
- G. Masking Tape: Removable paper or fiber tape, self-adhesive, non-staining.

2.9 DETECTABLE WARNING SURFACE

- A. Units shall be composed of cementitious materials, steel, iron, plastics, polymeric materials, resins, pigments, or as approved by the Engineer.
- B. Owner/Architect to select final color.
- C. Units shall provide the required contrast (light-on-dark or dark-on-light) with the adjacent curb ramp or other applicable walkway. The units shall be uniform in color and texture, be free of cracks or other defects, and have clean-cut and well-defined edges.
- D. Units shall adhere to hot mix asphalt (HMA) or Portland cement concrete (PCC) surfaces at a minimum air temperature of 60°F, and a minimum surface substrate temperature of 70°C. They shall be weather resistant and durable to normal pedestrian wear and maintenance activities, and show no appreciable fading, lifting or shrinkage. The unit shall be capable of molding or fitting itself to the contours, breaks, and faults of HMA or PCC surfaces, and show no significant tearing, rollback, lifting, or other signs of poor adhesions. The units shall have friction characteristics similar to a broomed PCC surface.
- E. The detectable warnings shall meet the following physical properties:

Standard	Property	Results
ASTM C-501	Wear Resistance	Wear Index ≥ 15
ASTM C1028	Slip Resistance	Dry Coefficient of friction 0.8 minimum
ASTM E-96	Water Vapor Transmission	100 grams/sq. meter/24 hours
Various	Adhesion/Bonding Strength	See Note*

*Note: Due to the various types of materials available, the Manufacturer shall certify, through independent laboratory testing, that the type of material used for detectable warnings will bond to a prepared surface.

F. Construction Methods

1. Preformed, surface applied, detectable warning units shall be shipped and packaged in accordance with commercially accepted standards. The following information shall be marked on each package or on the shipping invoice: the name of the product, the name and address of the manufacturer, and the quantity of material.
2. Detectable warnings shall consist of raised truncated domes with a diameter of nominal 0.9 in-1.41 in, a height of nominal 0.2 in and a center-to-center spacing of nominal 1.625-2.41 in and shall contrast visually with adjoining surfaces, either light-on-dark, or dark-on-light.
3. The material used to provide contrast shall be an integral part of the walking surface. Detectable warnings used on interior surfaces shall differ from adjoining walking surfaced in resiliency or sound-on-cane contact.
4. Detectable warnings must have a visual contrast of 70% or more to the surrounding surface.
5. Detectable warnings must be 24 inches for the full width of the ramp.
6. A protective sealer shall be applied over the entire ramp to produce a durable wearing surface.

2.10 PRODUCTION (Amendments to ACI 301, Chapter 7):

- A. Provide ready-mixed concrete, either central-mixed or truck-mixed.
 - 1. When air temperature is between 85 and 90 deg. Reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F reduce mixing and delivery time to 60 minutes.
 - 2. Provide adequate controls to ensure that the temperature of the concrete when placed does not exceed 90 degrees F. and make every effort to place it at a lower temperature. The temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set or cold joints. Ingredients may be cooled before mixing by shading the aggregates, fog spraying the coarse aggregate, chilling the mixing water or other approved means. Mixing water may be chilled with flake ice or well-crushed ice of a size that will melt completely during mixing, providing the water equivalent of the ice is calculated into the total amount of mixing water.
 - 3. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placement and curing.
 - 4. In cold weather, comply with ACI 306R.
 - a. When air temperature is below 40 degrees F (4 degrees C) heat the mixing water and, if necessary, the aggregates to obtain a concrete mixture temperature of not less than 50 degrees F (10 degrees C) and not more than 80 degrees F (27 degrees C) at point of placement. If the mixing water is heated, do not exceed a temperature of 140 degrees F at the time it is added to the cement and aggregates.
 - 5. In hot weather, comply with ACI 305R.
 - a. When air temperature is between 85 degrees F (30 degrees C) and 90 degrees F (32 degrees C), reduce mixing and delivery time from 1 1/2 hours to 75 minutes, and when air temperature is above 90 degrees F (32 degrees C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Do not use items of aluminum for mixing, chuting, conveying, forming or finishing concrete, except magnesium alloy tools may be used for finishing.
- B. Check items of aluminum required to be embedded in the concrete and insure that they are coated, painted or otherwise isolated in an approved manner.
- C. Install waterstops in accordance with manufacturer's printed instructions.
- D. Hardened concrete, reinforcement, forms, and earth which will be in contact with fresh concrete shall be free from frost at the time of concrete placement.
- E. Do not deposit concrete in water. Keep excavations free of water by pumping or by other approved methods.
- F. Prior to placement of concrete, remove all hardened concrete spillage and foreign materials from the space to be occupied by the concrete.

3.2 FORMWORK INSTALLATION

- 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 structure can support such loads. As deemed necessary by the Contractor, the contractor shall engage the services of a licensed design professional to oversee the design of the formwork system.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch for rough-formed finished surfaces.
- C. Construct forms tight enough to prevent loss of concrete mortar.
- D. Construct 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.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- E. 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.
- F. 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.
- G. Chamfer exterior corners and edges of permanently exposed concrete. Chamfer shall be 3/4" minimum, unless otherwise noted on the project documents.
- H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.3 EMBEDDED ITEM INSTALLATION

- 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 rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

3.4 STEEL REINFORCEMENT INSTALLATION

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.
- 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.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded-wire reinforcement 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. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement

3.5 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 identified on the contract drawings and/or on submittal approved by Engineer.
 - 1. Continue reinforcement across construction joints unless otherwise indicated.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Space vertical joints in walls as indicated on the project documents. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible. All proposed joint locations shall be submitted to the Engineer for approval during the submittal process.
 - 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. 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-joints into concrete when cutting

action does 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 inches more than 1 inches below finished concrete surface where joint sealants.
 - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 CONCRETE PLACEMENT

- A. Comply with ACI 301 for placing concrete.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- C. Consolidate concrete with mechanical vibrating equipment according to ACI 301.

3.7 APPLICATION OF CLSM

- A. Examine conditions of substrates and other conditions under which work is to be performed and notify the Engineer in writing, of circumstances detrimental to the proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.
- B. Keep excavations free of water. Do not deposit CLSM in water.
- C. Hardened CLSM, forms, and earth which will be in contact with fresh CLSM shall be free from frost at the time of CLSM placement.
- D. Prior to placement of CLSM, remove all foreign materials from the space to be occupied by the CLSM.

3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding 1/2 inch.
 - 1. Apply to concrete surfaces not exposed to public view.
- 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.
 - 1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish.

- C. Rubbed Finish: Apply the following rubbed finish, defined in ACI 301, to smooth-formed-finished as-cast concrete where indicated:
 - 1. Smooth-rubbed finish.
 - 2. Cork-floated finish.
- 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.

3.9 FINISHING UNFORMED SURFACES

- A. General: Comply with ACI 302.1R for screening, re-straightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- C. 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 defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
- D. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:
 - 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 1-part portland cement to 1-1/2 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 matches 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 1-part portland cement and 1-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 matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- E. 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 ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Floated Finish: Slabs and fill over which waterproofing, roofing, vapor barrier, insulation, terrazzo, or resin bound flooring is required.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance.
- D. Broom Finish

3.11 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the 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.

3.12 CONCRETE PROTECTING AND CURING

- A. Hot Weather Concreting: Comply with ACI 305R whenever the atmospheric temperature or the form surface temperature is at or above 90 degrees F., or climatic conditions of wind and/or low humidity will cause premature drying of the concrete.
- B. Curing Temperature: Maintain the temperature of the concrete at 50 degrees F. or above during the curing period. Keep the concrete temperature as uniform as possible and protect it from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5 degrees F, in any one hour and 50 degrees F, in any 24-hour period.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. 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.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure formed and unformed concrete for at least seven days 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 lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
3. 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.

3.13 JOINT PREPARATION

- A. Clean joint surfaces immediately before installation of sealant and other materials specified in this Section.
 1. Remove all loose materials, dirt, dust, rust, oils and other foreign matter that will impair the performance of materials installed under this Section. When necessary or when directed, wire brush, grind, or acid etch to thoroughly clean joint surfaces.
- B. Joint Filler Installation
 1. Set joint fillers at proper depth and position as required for installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between the ends of joint filler units.
 - a. Smooth Edged Joints: For joints between two concrete slabs or where new concrete abuts smooth edged materials use either filler as specified.
 - b. Irregular Edged Joints: For joints where new concrete abuts granite curbs or other irregular edges use closed cell polyurethane joint filler.
- C. Backer Rod and Bond Breaker Tape Installation
 1. Install bond breaker tape in relaxed condition as it comes off the roll. Do not stretch the tape. Lap individual lengths.
 2. Provide backer rod of sufficient size to fill the joint width at all points in a compressed state. Compress backer rod at the widest part of the joint by a minimum of 25 percent. Do not cut or puncture the surface skin of the rod.
- D. Sealant Installation
 1. Except as shown or specified otherwise, install sealants in accordance with the manufacturer's printed instructions.
 2. Prime joint surfaces which are to receive Type 1A Sealant. Do not allow the primer to spill or migrate onto adjoining surfaces.
 3. Apply sealant with ratchet handgun or another approved mechanical gun. Where gun application is impractical, apply sealant by knife or by pouring as applicable.
 4. Finishing: Tool all vertical, non-sag sealants to compress the sealant and eliminate air voids. Provide a neat smoothly finished joint with a slightly concave surface unless otherwise indicated or recommended by the manufacturer.
 - a. Use tool wetting agents as recommended by the sealant manufacturer.
- E. Cleaning
 1. Immediately remove misapplied sealant and drippings from metal surfaces with solvents and wiping cloths. On other materials, remove misapplied sealant and

droppings by methods and materials recommended in writing by the manufacturer of the sealant material.

2. After sealants are applied and before skin begins to form on sealant, remove all masking and other protection and clean up any remaining defacement caused by the Work.

3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by the Engineer. Remove and replace concrete that cannot be repaired and patched to the Engineer's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1-part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 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 any dimension to solid concrete. Limit cut depth to 3/4 inch. 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 matches 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 the Engineer.
- 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 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 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 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 a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture 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 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 the Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to the Engineer's approval.

3.15 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Inspections:
1. Steel reinforcement placement in accordance with ACI 318 Sections 3.5 and 7.1-7.7.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing in accordance with ACI 318 Sections 5.9 and 5.10
 4. Curing procedures and maintenance of curing temperature.
 5. Verification of concrete strength before removal of shores and forms in accordance with ASTM C39.
- C. Concrete Tests: 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 mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, 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 mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31.
 - a. Cast and laboratory cure cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39; at a minimum test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
8. Test results shall be reported in writing to Owner and Engineer, 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 mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
10. 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 the Engineer. The cost for the additional testing shall be borne by the Contractor. 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 the Engineer.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 033000

SECTION 035400 – CEMENTITIOUS UNDERLAYMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This section specifies self-leveling underlayment applied to interior concrete surfaces.

1.2 RELATED SECTIONS

- A. Section 096519 – Resilient Tile Flooring.

1.3 REFERENCES

- A. American Society for Testing and Materials:
 - 1. ASTM C-230 – Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
 - 2. ASTM C-1583 – Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)
 - 3. ASTM C-1708 – Standard Test Methods for Self-leveling Mortars Containing Hydraulic Cements
 - 4. ASTM F-2873 – Standard Practice for the Installation of Self-Leveling Underlayment and the Preparation of Surface to Receive Resilient Flooring
- B. Other Test Methods:
 - 1. TDS 235 – Self-Leveling Flow Test.

1.4 SUBMITTALS

- A. Submit under provisions of Section 013300 – Submittal Procedures
 - 1. Product Data: Manufacturer's literature to include surface preparation, application instructions, recommendations and storage and handling requirements.
 - 2. Test Data: Confirm compliance and performance with specified requirements.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: Applicator must have prior experience applying specified product or similar products or have manufacturer's representative on site ensuring that preparation and application are performed correctly.

B. Mockup:

1. Architect will select area for mockup.
2. Prior notice will be given to architect four (4) business days before mockups will be applied.
3. Architect must approve mockup before final product is applied.
4. At the architect's discretion, approved mockups may become incorporated into the final work.

1.6 DELIVERY, STORAGE & HANDLING

- A. Materials must be delivered in original, unopened containers with the manufacturer's labels including product name and batch numbers.
- B. Store material in a dry area, above ground. Protect cement from moisture and humidity.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Environmental Conditions: Do not apply material when temperature is below 45°F or when temperature is expected to fall below 45°F within 48 hours.
- B. Protection: Precautions should be taken to avoid damage to any surface near the work zone.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Acceptable Manufacturer:
1. Laticrete, 1 Laticrete Park North, Bethany, CT 06524, 800-243-4788, <https://www.laticrete.com>.
 2. Or approved equal.

2.2 MATERIALS

- A. Self-Leveling Underlayment:
1. NXT® LEVEL Plus Lite Self Leveling Underlayment
 - a. Description: Cement-based, fiber reinforced, self-leveling product that can be applied in uniform thicknesses from 1/8 inch to 4 inches and can be feathered at edges to match adjacent floor elevations.
 2. Or approved equal.

2.3 MATERIAL PROPERTIES

- A. 28-Day Compressive Strength (ASTM C-1708): 4,400 psi minimum.
- B. 28-Day Flexural Strength (ASTM C-1708): 950 psi minimum.
- C. 28-Day Tensile Bond Strength (ASTM C-1583): 350 psi minimum.
- D. Time to Foot Traffic: 3-4 Hours.
- E. VOC Content: 0.00 g/L.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be repaired. Notify Architect if surfaces are unacceptable. Do not begin surface preparation or application until unacceptable conditions are corrected.

3.2 SURFACE PREPARATION

- A. General: Prepare and clean substrate according to manufacturer's recommendations for substrate indicated. Provide clean, dry substrate for underlayment application.
 - 1. Treat non-moving substrate cracks to prevent cracks from telegraphing (reflecting) through underlayment according to manufacturer's recommendations.
- B. Concrete Substrates: Mechanically profile existing concrete floor to 1/8" depth, as shown by the International Concrete Repair Institute CSP tile #4. Ensure that all laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and all materials that may inhibit bond of underlayment to substrate have been removed.
- C. Priming Substrate: Prime concrete substrate using floor primer specified. Priming instructions may vary according to the porosity of the concrete. Multiple coats may be necessary.

3.3 MIXING

- A. Proportion product and water in accordance with manufacturer's written instructions.
- B. A flow test should always be performed to ensure that the mix is homogeneous and free from separation. Perform flow test in accordance with manufacturer's written instructions.

3.4 APPLICATION

- A. Substrate temperature must be between 45 – 90°F during application and air temperature maintained between 50 – 90°F. Protect areas from direct sunlight. Do not use damp curing methods, curing compounds or sealers. If required to meet level tolerances, survey surface using a digital or electronic leveling device and apply level pegs as required. Adequate ventilation should be provided to ensure uniform drying. Pump or pour blended material onto substrate at an average thickness ranging between 1/8 inch to 4 inches.
- B. Immediately following placement, lightly smooth the surface and pour lines. Do not expose self-leveling underlayments to rolling dynamic loads, such as forklifts or scissor lifts, for at least 72 hours after installation at 70°F.

3.5 FINISHING

- A. Immediately before installation of flooring, as recommended by flooring and adhesive manufacturer and in accordance ASTM F2873 - Installation of Self-Leveling Underlayment & Preparation of Surface to Receive Resilient Flooring, the self-leveling surface may require preparation including cleaned of all loose material by scraping, sanding, vacuuming, and primer application or a combination thereof.

3.6 PROTECTION

- A. Protect horizontal surfaces from traffic until underlayment has cured.

END OF SECTION 035400

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:
 - 1. Concrete masonry units (CMUs).
 - 2. Decorative concrete masonry units.
 - 3. Acoustic Masonry Units.
 - 4. Face brick.
 - 5. Stone trim units.
 - 6. Mortar and grout.
 - 7. Reinforcing steel.
 - 8. Masonry joint reinforcement.
 - 9. Ties and anchors.
 - 10. Embedded flashing.
 - 11. Miscellaneous masonry accessories.
 - 12. Cavity-wall insulation.
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Anchor sections of adjustable masonry anchors for connecting to structural frame, installed under Division 05 Section "Structural Steel Framing."
- C. Products installed, but not furnished, under this Section include the following:
 - 1. Steel lintels for unit masonry, furnished under Division 05 Section "Metal Fabrications."

1.3 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.
- B. Match Existing: Material that is noted to match existing will match the entire masonry system including the masonry size, shape color, texture as well as the mortars size color texture and joint finish. Metric sized masonry is not to be used as a match to imperial sized units.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops indicated net-area compressive strengths (f'_m) at 28 days.
- B. Determine net-area compressive strength (f'_m) 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 and Tables 2105.2.2.1.1 & 2105.2.2.1.2 in the Building Code of New York State.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
 - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection: For the following:
 - 1. Decorative concrete masonry units, in the form of small-scale units.
 - 2. Face brick, in the form of straps of five or more bricks.
 - 3. Colored mortar.
- D. Samples for Verification: For each type and color of the following:
 - 1. Decorative concrete masonry units.
 - 2. Face brick, in the form of straps of five or more bricks.
 - 3. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
 - 4. Weep holes/vents.
 - 5. Accessories embedded in masonry.
- E. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
 - 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements and FM2000.

- b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 - 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.
- F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
- 1. Include test reports, per Building Code of New York State 2105.4 and ASTM C 780 for mortar mixes required to comply with property specification.
 - 2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- G. 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 and Tables 2105.2.2.1.1 & 2105.2.2.1.2 in the Building Code of New York State.
- H. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.6 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, through one source from a 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 a single manufacturer for each cementitious component and from one source or producer for each aggregate.
- C. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Payment for these services will be made by Owner. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.
 - 1. Mortar Test For each mix required, per ASTM C 780 and Building Code of New York State 2105.4.

2. Grout Test (Compressive Strength): For each mix required, per ASTM C 1019 and Building Code of New York State 2105.5.
- D. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.
- E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Build mockups for each type of exposed unit masonry construction in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high by full thickness, including face and backup wythes and accessories.
 - a. Include a sealant-filled joint at least 16 inches (400 mm) long in each exterior wall mockup.
 - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches (300 mm) wide by 16 inches (400 mm) high.
 - c. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of exterior wall mockup approximately 16 inches (400 mm) down from top of mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Include metal studs, sheathing, veneer anchors, flashing, and weep holes in exterior masonry-veneer wall mockup.
 2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
 3. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
 4. Protect accepted mockups from the elements with weather-resistant membrane.
 5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
 6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 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 lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 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 (600 mm) down both sides and hold cover securely in place.
 - 2. Where one (1) wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least twelve (12) hours and concentrated loads for at least three (3) days after building masonry walls or columns.
- C. 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 meet 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.
- D. 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-conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS602 and Building Code of New York State 2104.3.
 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 CONCRETE MASONRY UNITS (CMUs)

- A. Shapes: Provide shapes indicated and as follows:
 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide bullnose units for (Interior) outside corners, unless otherwise indicated.

3. Provide 'L' shaped blocks at all outside corners of CMU walls, unless otherwise indicated.
- B. Integral Water Repellent: Provide units made with integral water repellent for (exterior) exposed units .
 1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water, or leaks on the back of test specimen.
 - a. Available Products:
 - 1) Addiment Incorporated; Block Plus W-10.
 - 2) Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block.
 - 3) Master Builders, Inc.; Rheopel.
 - 4) Forrer Industries; Dry-Block.
- C. Concrete Masonry Units: Building Code of New York State 2103.1 and ASTM C90.
 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi (19.3 MPa).
 2. Weight Classification: Lightweight. Normal weight CMU shall be for load bearing walls as indicated on structural drawings.
 3. Size (Width): Manufactured to dimensions 3/8-inch less than nominal dimensions.
 4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample or where indicated on the drawings to "match existing", match the adjacent color and texture.
 5. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.
- D. Decorative Concrete Masonry Units: ASTM C90.
 1. Basis of Design: Westbrook Concrete Block.
 - a. Approved equal: A. Jandris Block.
 2. Type: Architectural CMU.
 3. Density Classification: Normal weight.
 4. Texture: Ground-face.
 5. Size: 8" x 8" x 16" nominal.
 6. Finish: As selected by Architect from manufacturer's full range.

2.4 BRICK

- A. General: Provide shapes indicated and as follows:

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.

B. Face Brick: ASTM C 216 , Grade SW , Type FBS .

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.7 MPa).
2. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67.
3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
4. 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 (3 m).
5. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long.
6. Application: Use where brick is exposed, unless otherwise indicated.
7. Where shown to "match existing," provide face brick matching color range, texture, and size of existing adjacent brickwork.
8. Products:
 - a. Continental Brick Company

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement-Lime Mix: Packaged blend of Portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
- B. Mortar Cement: ASTM C 1329.
 1. Available Products:
 - a. Lafarge North America Inc.; Lafarge Mortar Cement or Magnolia Superbond Mortar Cement.
 - b. Or equal.
- C. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
 1. Available Products:
 - a. Bayer Corporation, Industrial Chemicals Div.; Bayferrox Iron Oxide Pigments.
 - b. Davis Colors; True Tone Mortar Colors.

- c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.
- D. Aggregate for Mortar: ASTM C 144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 2. For joints less than 1/4-inch (6.5 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
 - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
- E. Aggregate for Grout: ASTM C 404.
- F. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.
- G. Cold-Weather Admixture: Non-chloride, non-corrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 - 1. Available Products:
 - a. Addiment Incorporated; Mortar Kick.
 - b. Euclid Chemical Company (The); Accelguard 80.
 - c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
 - d. Sonneborn, Div. of ChemRex; Trimix-NCA.
 - e. Approved equal.
- H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
 - 1. Available Products:
 - a. Addiment Incorporated; Mortar Tite.
 - b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
 - c. Approved equal.
- I. Water: Potable.

2.6 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from

0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

- C. Masonry Joint Reinforcement, General: ASTM A 951 Building Code of New York 2103.11.2.
 - 1. Interior Walls: Hot-dip galvanized, carbon steel.
 - 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 - 3. Wire Size for Side Rods: W1.7 or 0.148-inch (3.8-mm) diameter.
 - 4. Wire Size for Cross Rods: W1.7 or 0.148-inch (3.8-mm) diameter.
 - 5. Wire Size for Veneer Ties: W1.7 or 0.148-inch (3.8-mm) diameter.
 - 6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
 - 7. Provide in lengths of not less than 10 feet (3 m) with prefabricated corner and tee units.
- D. Masonry Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.
 - 1. Available Products:
 - a. Hohmann & Barnard, Inc. #220
 - b. Dur-o-wall #DA3200
 - c. Approved equal
- E. Masonry Joint Reinforcement for Multi-wythe Masonry:
 - 1. Adjustable (two-piece) type, ladder design, with one side rod at each face shell of backing wythe and with separate ties that extend into facing wythe. Ties have two hooks that engage eyes or slots in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face.
 - a. Available Products:
 - 1) Hohmann & Barnard, Inc. #285 Ladder with 3/16" BYNA-Lock wire tie
 - 2) Approved equal
- F. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.188-inch- (4.8-mm-) diameter, stainless-steel continuous wire.

2.7 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with subparagraphs below, unless otherwise indicated.
 - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.

2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
 3. Stainless-Steel Sheet: ASTM A 666, Type 304.
- B. Corrugated Metal Ties: Not allowed anywhere.
- C. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.
- D. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.
1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches (50 mm) long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
 2. Where wythes are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).
 3. Wire: Fabricate from 3/16-inch- (4.8-mm-) diameter, hot-dip galvanized steel wire.
- E. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.4-mm-) diameter, hot-dip galvanized steel wire.
 - a. Available Products:
 - 1) Hohmann & Barnard, Inc. #359-C (with back plate)
 - 2) Approved equal.
 2. Tie Section for Steel Frame: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.25-inch- (6.4-mm-) diameter, hot-dip galvanized steel wire.
 - a. Available Products:
 - 1) Hohmann & Barnard, Inc. #301W (size as required)
 - 2) Approved equal
 3. Anchor Section for Anchoring across movement joints: (2) 1/4-inch- (6.4-mm-) diameter, hot-dip galvanized steel wire with (2) hot-dip galvanized plates.
 - a. Available Products:
 - 1) Hohmann & Barnard, Inc. #Slip-Set Stabilizer Style "H"
 - 2) Approved equal
- F. Partition Top anchors: 0.097-inch- (2.5-mm-) thick metal plate with 3/8-inch- (10-mm-) diameter metal rod 6 inches (150 mm) long welded to plate and with closed-end plastic

tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

1. Available Products:
 - a. Hohmann & Barnard, Inc. #PTA-420, NS-TA, & PTA tube.
 - b. Approved equal.
- G. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (600 mm) long, with ends turned up 2 inches (50 mm) or with cross pins, unless otherwise indicated.
 1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M .
 - a. Available Products:
 - 1) Hohmann & Barnard, Inc. #344
 - 2) Approved equal
- H. Adjustable Masonry-Veneer Anchors
 1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
 - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play more than 0.05 inch (1.3 mm).
 2. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
 - a. Anchor Section: Gasketed sheet metal plate, 1-1/4 inches (32 mm) wide by 6 inches (150 mm) long, with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, 5/8 inch (16 mm) wide by 6 inches (150 mm) long, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.
 - b. Anchor Section: Sheet metal plate, 14 gage, 1-1/4 inches (32 mm) wide by length required, 5/8-inch (16 mm) wide by 5-1/2 inches (140 mm) long, stamped into center to provide a slot between strap and plate for inserting sheet metal plate.
 - c. Wire Ties: Triangular-, rectangular-, 0.188-inch- (4.8-mm-) diameter, hot-dip galvanized steel wire.
 - d. Available Products:
 - 1) Hohmann & Barnard, Inc.; DW-10-X.
 - 2) Wire-Bond; 1004, Type III-X .

3. Seismic Masonry-Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in the veneer mortar joint.
 - a. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (75 mm) high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit anchor section. Size wire tie to extend at least 1-1/2 inches (38 mm) into veneer but with at least 5/8-inch (16-mm) cover on outside face.
 - b. Connector Section: Sheet metal clip welded to wire tie with integral tabs designed to engage continuous wire.
 - c. Anchor Section: Gasketed sheet metal plate, 1-1/4 inches (32 mm) wide by 6 inches (150 mm) long, with screw holes top and bottom; top and bottom ends bent to form pronged legs to bridge insulation or sheathing and contact studs; and raised rib-stiffened strap, 5/8 inch (16 mm) wide by 6 inches (150 mm) long, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.
 - d. Connector Section: Triangular wire tie and rigid PVC extrusion with snap-in grooves for inserting continuous wire. Size wire tie to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face.
 - e. Available Products:
 - 1) Hohmann & Barnard, Inc.; DW-10-X-Seismicclip.
 - 2) Wire-Bond; RJ-711 with Wire-Bond clip.
4. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads.
 - a. Available Products:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; Stainless Steel SX Fastener.
 - 2) ITW Buildex; Scots long life Tek.
 - 3) Approved equal.

2.8 MISCELLANEOUS ANCHORS

- A. Special masonry anchors not specifically identified shall be provided as part of the work. Such anchors will be submitted to the architect for review prior to their use and shall meet the structural performance required.

2.9 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual " and as follows:
 - 1. Metal Drip Edges: Fabricate from stainless steel. Extend to inner width of wall and turn up 1 inch. Project drip edge 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed. Provide pre-fabricated corners free of sharp edges at all outside corner locations.
 - 2. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 3/8 inch (10 mm) to form a stop for retaining sealant backer rod.
- B. Flexible Flashing, Thru-Wall Flashing: Use the following unless otherwise indicated:
 - 1. Stainless Steel Fabric: 304 stainless steel sheet bonded to polymeric fabric with adhesive backing. Use only where flashing is fully concealed in masonry.
 - a. Products:
 - 1) Hohmann & Barnard, Inc.; Mighty Flash SA.
 - 2) York Flashings; Multi-Flash SS.
 - 2. Termination Bar: At all horizontal terminations:
 - a. Rigid Thermoplastic extrusion by York Flashings; Termination Bar.
- C. Solder and Sealants for Sheet Metal Flashings:
 - 1. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
 - 2. Elastomeric Sealant: ASTM C 920, chemically curing silicone 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.

2.10 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Pre-molded 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. Mortar/Grout screen: At locations where grout isolation is required. ¼" square monofilament screen fabricated from high strength, non-corrosive polypropylene.
 - 1. Available Products:
 - a. Hohmann & Barnard, Inc. #MGS – Mortar / Grout Screen.
 - b. Approved equal.
- E. Weep/Vent Products: Use the following, unless otherwise indicated:
 - 1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. Products:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
 - 2) Heckmann Building Products Inc.; No. 85 Cell Vent.
 - 3) Hohmann & Barnard, Inc.; Quadro-Vent.
 - 4) Wire-Bond; Cell Vent.
- F. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. Provide one of the following configurations:
 - a. Strips, full-depth of cavity and 10 inches (250 mm) high, with dovetail shaped notches 7 inches (175 mm) deep that prevent mesh from being clogged with mortar droppings.
 - 2. Available Products:
 - a. Archovations, Inc.; CavClear Masonry Mat.
 - b. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
 - c. Mortar Net USA, Ltd.; Mortar Net.
 - d. Approved equal.
- G. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch (3.6-mm) steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.
 - 1. Available Products:

- a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812, or D/A 817.
 - b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
 - c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
 - d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.
 - e. Approved equal.
 - H. Self-Sealing Penetration Tape: Adhesive backed tape for use under surface applied veneer anchors as an air and moisture barrier.
 - 1. Basis of Design: Hohmann & Barnard; X-Seal tape, or equal.
- 2.11 CAVITY-WALL INSULATION
- A. See Section 072100 Thermal Insulation.
- 2.12 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. Available Manufacturers:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.
 - d. Approved equal.
- 2.13 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. Limit cementitious materials in mortar to Portland cement and lime.
 - 3. Limit cementitious materials in mortar for exterior and reinforced masonry to Portland cement and lime.
 - 4. 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. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270 BIA Technical Notes 8A, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of mason.
 - 1. For masonry below grade or in contact with earth, use Type S.
 - 2. For reinforced masonry, use Type N.
 - 3. For mortar parge coats, use Type N.
 - 4. 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.
 - 5. For interior non-load-bearing partitions, Type O may be used instead of Type N.
- D. Pigmented Mortar: Use colored cement product [or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products].
 - 1. Pigments shall not exceed ten percent (10%) of Portland cement by weight.
 - 2. Mix to match Architect's sample.
- E. 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 C476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
 - 3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.
- F. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

2.14 SOURCE QUALITY CONTROL

- A. Owner will engage a qualified independent testing agency to perform source quality-control testing indicated below:
 - 1. Payment for these services will be made by Owner.
 - 2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

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 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. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.
- F. Matching Existing Masonry: Match coursing, bonding, color, sizes and texture of existing masonry and mortar.

1. Note: Bonding is different on the various additions. Note locations of the 'Flemish Bond' locations.
- G. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
1. 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 (3 mm in 3 m), 1/4-inch in 20 feet (6 mm in 6 m), or 1/2-inch (12 mm) maximum.
 2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4-inch in 10 feet (6 mm in 3 m), or 1/2-inch (12 mm) maximum.
 3. 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 (3 mm in 3 m), 1/4-inch in 20 feet (6 mm in 6 m), or 1/2-inch (12 mm) maximum.
 4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm). Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
 5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).
 6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.
 7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
1. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond ; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs. Note: Bonding is different on the various additions. Note locations of the 'Flemish Bond' indicated.
- B. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches (100-mm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

- C. 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.
- D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- E. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- F. 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.
- G. Fill cores in hollow concrete masonry units with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- H. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.
 - 1. Install compressible filler in joint between top of partition and underside of structure above.
 - 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c., unless otherwise indicated.
 - 3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Fire-Resistive Joint Systems."

3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow concrete masonry units 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 and slabs..
- B. Lay solid masonry units (and hollow masonry 4" in width and less) with completely-filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- D. Tool joints flush for masonry walls to receive plaster. unless otherwise indicated.
- E. Rake top of horizontal joints and fill with sealant

3.5 COMPOSITE MASONRY

- A. Bond wythes of composite masonry together using one of the following methods:
 - 1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 1.77 sq. ft. (0.16 sq. m) of wall area spaced not to exceed 16 inches (406 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
 - a. Where bed joints of wythes do not align or where the wythes are of different material, use adjustable (two-piece) type ties.
 - 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes .
 - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties].
- B. Bond wythes of composite masonry together using bonding system indicated on Drawings.
- C. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.
- D. Corners: Provide interlocking masonry unit bond in each wythe and course at corners, unless otherwise indicated.
 - 1. Provide continuity with masonry joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.
- E. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
 - 1. Provide rigid metal anchors not more than 24 inches (610 mm) o.c. If used with hollow masonry units, embed ends in mortar-filled cores or tooth intersecting walls together

3.6 CAVITY WALLS

- A. Bond wythes of cavity walls together using one of the following methods:
1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 1.77 sq. ft. (0.16 sq. m) of wall area spaced not to exceed 16 inches (406 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
 - a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
 - b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.
 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
 - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement.
 - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement to allow for differential movement regardless of whether bed joints align.
 3. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.
- B. Bond wythes of cavity walls together using bonding system indicated on Drawings.
- C. 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.
- D. Coat cavity face of backup wythe to comply with Division 07 Section "Bituminous Dampproofing." or "Air barrier" where indicated.
- E. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c. both ways, on inside face of insulation boards,. 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.

3.7 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
 - 1. Space reinforcement not more than 16 inches (406 mm) o.c.
 - 2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings.
- 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.

3.8 ANCHORING MASONRY TO STRUCTURAL MEMBERS

- A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
 - 1. Provide an open space not less than 1 inch (25 mm) in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.9 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to wall framing concrete and masonry backup with seismic masonry-veneer anchors to comply with the following requirements:
 - 1. Fasten screw-attached and seismic anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 - 2. Embed tie sections and connector sections and continuous wire in masonry joints. Provide not less than 2 inches (50 mm) (unless noted otherwise) of air space between back of masonry veneer and face of sheathing.
 - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.

4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 16 inches (610 mm) o.c. horizontally, with not less than 1 anchor for each 1.66 sq. ft. of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 8 inches (203 mm), around perimeter.

3.10 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. Install preformed control-joint gaskets designed to fit standard sash block.
 2. Install control joints where shown on plans. If a masonry span exceeds 30 feet horizontally and no control joint is shown, provide a control joint every 30 feet +/- where directed by architect.
 3. Openings over 48" in width will have a control joint. Request location from architect if not shown on drawings.
 4. Openings over 96" in width will have two control joints. Request location from architect if not shown on drawings.
 5. Corners will have a control joint located within 24" of a corner. Request location from architect if not shown on drawings.
- C. Form expansion joints in brick made from clay or shale as follows:
 1. Form open joint full depth of brick wythe and of width indicated, but not less than 1/2 inch (13 mm) for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."
- D. Provide horizontal, pressure-relieving joints by inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 1/2 inch (13 mm).
 1. Locate horizontal, pressure-relieving joints beneath steel angles.

3.11 LINTELS

- A. Install steel lintels where indicated.
- B. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches (200 mm) at each jamb, unless otherwise indicated.

3.12 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 metal 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. Form end dams at (1" minimum tapering up to full flashing height) all location where water has the potential of flowing off the sides of the flashing back into adjacent masonry, or masonry cavities.
 - 2. At multi-wythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 12 inches (300mm), and 1-1/2 inches (38 mm) into the inner wythe. Form 1/4-inch (6-mm) hook in edge of flashing embedded in inner wythe.
 - 3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 12 inches (300mm); with upper edge tucked under building paper or building wrap, lapping at least 4 inches (100 mm). Secure with continuous termination bar.
 - 4. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
 - 5. Install stainless steel metal drip edges beneath fabric flashing at exterior face of wall. Stop fabric flashing 1/2 inch (13 mm) back from outside face of wall and adhere fabric flashing to top of metal drip edge in a full bed of butyl sealant.
- C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing, at top of exterior wythes, and as follows:
 - 1. Use specified weep/vent products to form weep holes.
 - 2. Space weep holes 24 inches (600 mm) o.c., unless otherwise indicated.
- E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

3.13 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602 Building Code of New York chapter 21.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 Building Code of New York chapter 21 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. Limit height of vertical grout pours to not more than 48 inches (1216mm).

3.14 FIELD QUALITY CONTROL

- A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
 - 1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
- B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
 - 1. Payment for these services will be made by Owner.
 - 2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
- C. Testing Frequency: One set of tests for each 5000 sq. ft. (465 sq. m) of wall area or portion thereof.
- D. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.

- E. Mortar Test (Property Specification): For each mix provided, per ASTM C 780. Test mortar for mortar air content and compressive strength.
- F. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.
- G. Prism Test: For each type of construction provided, per ASTM C 1314 at 7 days and at 28 days.

3.15 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's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and non-masonry 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 masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 - 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
 - 7. Clean stone trim to comply with stone supplier's written instructions.

3.16 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.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 - 1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.
 - 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earth Moving."
 - 3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Loose Lintels: Installed under Section 042000 or 042113 and 042200.

1.2 REFERENCES

- A. Except as shown or specified otherwise, the Work of this Section shall meet the requirements of the following:
 - 1. Design, Fabrication, and Erection: "Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design" adopted by the American Institute of Steel Construction, June 1, 1989 (AISC Specification).
 - a. Design and Fabrication of Cold-Formed Shapes: "Specification for the Design of Cold-Formed Steel Structural Members", by the American Iron and Steel Institute (AISI Specification).
 - 2. Welding: "Structural Welding Code - Steel, AWS D1.1", or "Structural Welding Code - Sheet Steel, AWS D1.3", by the American Welding Society (AWS Codes).
- B. Organizations:
 - 1. AISC: American Institute of Steel Construction, One East Wacker Dr., Suite 700, Chicago, IL 60601-1802, 866-275-2472, www.aisc.org.
 - 2. AISI: American Iron and Steel Institute, 1140 Connecticut Ave., NW, Suite 705, Washington, D.C. 20036, (202) 452-7100, www.steel.org.
 - 3. AWS: American Welding Society, 550 N.W. LeJeune Rd., Miami, FL 33126, (800) 443-9353, www.aws.org.
 - 4. ANSI: American National Standards Institute, 1819 L Street, NW, 6th Floor, Washington, DC 20036, (202) 293-8020, www.ansi.org.
 - 5. ASTM: ASTM International, 100 Barr Harbor Dr., PO Box C700, West Conshohocken, PA, 19428-2959, (610) 832-9500, www.astm.org.
 - 6. SSPC: The Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh PA 15222-4656, (877) 281-7772, www.sspc.org.

1.3 SUBMITTALS

- A. Shop Drawings: Show application to project. Furnish setting drawings and templates for installation of bolts and anchors in other Work. Indicate shop and field welds by standard AWS welding symbols in accordance with AWS A2.4.
- B. Product Data: Catalog sheets, specifications, and installation instructions for each fabricated item specified, except submit data for fasteners only when directed.
- C. Quality Control Submittals:

1. Certificates: Copy of certificates required under Quality Assurance Article.

1.4 QUALITY ASSURANCE

A. Certificates:

1. Affidavit by the structural steel manufacturer certifying that structural steel items meet the contract requirements.
 - a. Submit evidence of steel material compliance with this Specification. Evidence shall consist of certification of source of material, copies of purchase orders and manufacturer's certifications. For stock material, submit copies of latest mill or purchase orders for material replacement.

- B. Galvanizing: Stamp galvanized items with galvanizer's name, weight of coating, and applicable ASTM number.

1.5 DELIVERY AND STORAGE

- A. Coordinate delivery of items to be built into other construction to avoid delay.
- B. Promptly cover and protect steel items delivered to the Site.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Steel Plates: ASTM A 36, except as specified or shown otherwise.
- B. Angles: ASTM A 36 or ASTM A 572, Grade 50.
- C. Anchors: Except where shown or specified, select anchors of type, size, style, grade, and class required for secure installation of metal fabrications. For exterior use and where built into exterior walls, anchors shall be galvanized or of corrosive-resistant materials.
 1. Wedge-Type Concrete Inserts: Galvanized box-type ferrous casting, designed to accept 3/4-inch diameter bolt having special wedge-shaped head; either malleable iron or cast steel.
 - a. Bolts: Carbon steel bolts having special wedge-shaped heads, nuts, washers and shims.
- D. Fasteners: Except where shown or specified, select fasteners of type, size, style, grade, and class required for secure installation of metal fabrications. For exterior use and where built into exterior walls, fasteners shall be galvanized.
 1. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
 2. Machine Screws: ASME B18.6.3.
 3. Plain Washers: Round, ASME B18.22.1.
 4. Lock Washers: Helical, spring type, ASME B18.21.1.

- E. Shop Paint (General): Universal shop primer; fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- F. Shop Paint for Galvanized Steel: Epoxy zinc-rich primer; complying with MPI#20 and compatible with topcoat.
- G. Bedding Mortar:
 - 1. Shrink-Resistant Grout (Non-Staining): Factory-packaged, non-ferrous mortar grouting compound selected from the following:
 - a. Masterflow 713 by Master Builders, 23700 Chagrin Blvd., Cleveland, OH 44122 (800) 227-3350.
 - b. SonogROUT by Sonneborn, Chemrex, Inc., 57-46 Flushing Ave., Maspeth, NY 11378, (800) 433-9517.
 - c. Five Star Grout by Five Star Products, Inc., 425 Stillson Rd., Fairfield, CT 06430, (800) 243-2206.
 - d. Crystex by L&M Construction Chemicals, 14851 Calhoun Rd., Omaha, NB 68152, (800) 362-3331.
 - e. Non-Corrosive, Non-Shrink Grout by A.C. Horn, Inc., Tamm Industries, 7405 Production Dr., Mentor, OH 44060, (800) 862-2667.

2.2 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Fabricate metal framing and supports to support related items required by the Work. Fabricate of welded construction unless otherwise indicated. Preassemble to largest extent possible.
- B. When required to be built into other Work, equip units with integral anchors spaced not more than 24 inches on center.
- C. Galvanize exterior steel framing and supports.

2.3 LOOSE LINTELS

- A. Structural steel shape lintels, fabricated for openings and recesses in masonry walls and partitions as indicated. Loose lintels bearing on masonry or concrete shall have a minimum end bearing length of 6 inches at each end, unless otherwise shown.
- B. Galvanize lintels to be installed in exterior walls.

2.4 FABRICATION

- A. Use materials of size and thickness indicated. If not indicated, use material of required size and thickness to produce adequate strength and durability for the

intended use of the finished product. Furnish suitable, compatible anchors and fasteners to support assembly.

- B. Fabricate items to be exposed to view of material entirely free of surface blemish, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove surface blemishes by grinding or by welding and grinding prior to cleaning, treating, and finishing. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise shown.
- C. Joints: Fabricate accurately for close fit. Weld exposed joints continuously unless otherwise indicated or approved. Dress exposed welds flush and smooth.
- D. Connections: Form exposed connections with flush, smooth, hairline joints. Use concealed fasteners wherever possible. Use Phillips flathead (countersunk) bolts or screws for exposed fasteners, unless otherwise shown or specified.
 - 1. Furnish flat washer under connections requiring raised bolt heads.
 - 2. Furnish lock washer under nuts when through-bolting occurs.
- E. Punch, reinforce, drill, and tap metal Work as required to receive hardware and other appurtenant items.
- F. Galvanizing:
 - 1. In addition to specific items specified or noted to be galvanized, galvanize items attached to, embedded in, or supporting exterior masonry (including interior wythe of exterior masonry walls) and concrete Work.
 - 2. Unless otherwise specified or noted, items indicated to be galvanized shall receive a zinc coating by the hot-dip process, after fabrication, complying with the following:
 - a. ASTM A 123 for plain and fabricated material, and assembled products.
 - b. ASTM A 153 for iron and steel hardware.
- G. Shop Painting:
 - 1. Cleaning Steel: Thoroughly clean all steel surfaces. Remove oil, grease, and similar contaminants in accordance with SSPC SP-1 "Solvent Cleaning". Remove loose mill scale, loose rust, weld slag and spatter, and other detrimental material in accordance with SSPC SP-2 "Hand Tool Cleaning", SSPC SP-3 "Power Tool Cleaning", or SSPC SP-7 "Brush-Off Blast Cleaning".
 - 2. Galvanized Items:
 - a. Galvanized items which are to be finish-painted under Section 099101 shall be rinsed in hot alkali or in an acid solution and then in clear water.
 - b. Welded and abraded areas of galvanized surfaces shall be wire brushed and repaired with a coating of cold galvanizing compound.
 - 3. Apply one (1) coat of shop paint to all steel surfaces except as follows:
 - a. Do not shop paint steel surfaces to be field welded and steel to be encased in cast-in-place concrete.

- b. Apply two (2) coats of shop paint, before assembly, to steel surfaces inaccessible after assembly or erection, except surfaces in contact.
 - c. Do not paint galvanized items which are not to be finished painted under Section 099101.
- 4. Apply paint and compound on dry surfaces in accordance with the manufacturer's printed instructions, and to the following minimum thickness per coat:
 - a. Shop Paint (General): 4.0 mils wet film.
 - b. Shop Paint for Galvanized Steel: 3.0 mils wet film.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Temporarily brace and secure items which are to be built into concrete, masonry, or similar construction.
- B. Isolate non-ferrous metal surfaces to be permanently fastened in contact with ferrous metal surfaces, concrete, or masonry by coating non-ferrous metal surface with bituminous mastic, prior to installation.

3.2 INSTALLATION

- A. Fit and set fabricated metal Work accurately in location, alignment, and elevation. Securely fasten in place. Cut off exposed threaded portion of bolts flush with nut.
- B. Set loose items on cleaned bearing surfaces, using wedges or other adjustments as required. Solidly pack open spaces with bedding mortar or grout.
- C. Attached Work: Fasten to concrete and solid masonry with expansion anchors and to hollow masonry with toggle bolts in cells, unless otherwise indicated. Drill holes for fasteners to exact required size using power tools.

END OF SECTION 055000

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SECTION 055133 - METAL LADDERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Prefabricated ladders.

1.2 RELATED REQUIREMENTS

- A. Section 055213 - Pipe and Tube Railings.
- B. Section 118129 - Facility Fall Protection: Ladder safety systems.

1.3 REFERENCE STANDARDS

- A. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements; 2008 (Reaffirmed 2018).
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- C. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- D. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2022.
- E. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
- F. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).
- G. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.
- H. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Shop Drawings:
 - 1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
- C. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- D. Executed warranty.

1.5 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 5-year manufacturer warranty for material and workmanship. Complete forms in Owner's name and register with manufacturer.

PART 2 - PRODUCTS

2.1 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Bolts, Nuts, and Washers: ASTM A307, plain.
- C. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, plain.
- D. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- E. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- F. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.2 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.

- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.3 FABRICATED LADDERS

- A. Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; prime paint finish.
 - 1. Side Rails: 3/8 by 2 inches members spaced at 20 inches.
 - 2. Rungs: One inch diameter solid round bar spaced 12 inches on center.
 - 3. Space rungs 7 inches from wall surface.

2.4 FINISHES - STEEL

- A. Prime Painting: One (1) coat.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Obtain approval prior to site cutting or making adjustments not scheduled.

END OF SECTION 055133

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SECTION 055213 – PIPE AND TUBE RAILINGS

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Wall-mounted handrails.
- B. Stair railings and guardrails.

1.2 RELATED REQUIREMENTS

- A. Section 033000 – Cast-in-Place Concrete: Placement of anchors in concrete.
- B. Section 099100 – Painting.

1.3 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum 2020.
- B. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2022.
- C. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- E. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- F. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes 2023.
- G. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire 2019.
- H. ASTM B241/B241M - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube 2022.

- I. ASTM B429/B429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube 2020.
- J. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings 2021.
- K. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination 2020.
- L. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic) 2019.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's product data including description of materials, components, finishes, fabrication details, glass, anchors, and accessories.
- C. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
 - 2. Include the design engineer's seal and signature on each sheet of shop drawings.
- D. Designer's Qualification Statement.

1.5 QUALITY ASSURANCE

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

PART 2 – PRODUCTS

2.1 RAILINGS - GENERAL REQUIREMENTS

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

- B. Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 50 pounds per linear foot applied to the top of the assembly and in any direction, without damage or permanent set.
- C. Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds applied at any point on the top of the assembly and in any direction, without damage or permanent set.
- D. Allow for expansion and contraction of members and building movement without damage to connections or members.
- E. Dimensions: See drawings for configurations and heights.
 - 1. Top Rails and Wall Rails: 1-1/2 inches diameter, round.
 - 2. Intermediate Rails: 1-1/2 inches diameter, round.
 - 3. Posts: 1-1/2 inches diameter, round.
- F. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.

2.2 STEEL RAILING SYSTEM

- A. Steel Tube: ASTM A500/A500M Grade B cold-formed structural tubing.
- B. Steel Pipe: ASTM A53/A53M Grade B Schedule 80, black finish.
- C. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.
- D. Exposed Fasteners: No exposed bolts or screws.
- E. Galvanizing: In accordance with requirements of ASTM A123/A123M.
 - 1. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20 Type I - Inorganic.

2.3 FABRICATION

- A. Accurately form components to suit specific project conditions and for proper connection to building structure.
- B. Fit and shop assemble components in largest practical sizes for delivery to site.

- C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.
- D. Welded Joints:
 - 1. Exterior Components: Continuously seal joined pieces by continuous welds. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
 - 2. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

PART 3 – EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Supply items required to be cast into concrete or embedded in masonry with setting templates, for installation as work of other sections.

3.3 INSTALLATION

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

3.4 TOLERANCES

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

END OF SECTION 055213

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Framing with dimension lumber.
 - 2. Rooftop equipment bases and support curbs.
 - 3. Wood blocking and nailers.
 - 4. Wood furring and grounds.
 - 5. Wood sleepers.
 - 6. Utility shelving.
 - 7. Plywood backing panels for electric, phone, technology, and mechanical panels.

1.3 DEFINITIONS

- A. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
- B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NHLA: National Hardwood Lumber Association.
 - 3. NLGA: National Lumber Grades Authority.
 - 4. SPIB: The Southern Pine Inspection Bureau.
 - 5. WCLIB: West Coast Lumber Inspection Bureau.
 - 6. WWPAA: Western Wood Products Association.

1.4 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-preserved treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply

with requirements. Indicate type of preservative used and net amount of preservative retained.

2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency
3. cy.
4. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
5. For products receiving waterborne treatments, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
6. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Powder-actuated fasteners.
5. Expansion anchors.
6. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Steel Source: All steel specified in the Section shall be produced or made in North America, for the following items:

1. All types of Bolts.
2. All types of Anchors.

B. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 - 4. Provide dressed lumber, S4S, unless otherwise indicated.
- C. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 - 2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
 - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 - 3. Design Value Adjustment Factors: Treated lumber shall be tested according ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841.
- C. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- D. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- E. Application: Treat items indicated on Drawings, and the following:

1. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Blocking.
 2. Nailers.
 3. Rooftop equipment bases and support curbs.
 4. Sleepers.
 5. Utility shelving.
- B. For items of dimension lumber size, provide Standard, Stud, or No. 3 grade lumber and any of the following species:
 1. Hem-fir (north); NLGA.
 2. Spruce-pine-fir; NLGA.
 3. Hem-fir; WCLIB or WWPA.
- C. For utility shelving, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
 1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or No. 2 Common (Sterling) grade; NeLMA, NLGA, WCLIB, or WWPA.
 2. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common grade; NLGA, WCLIB, or WWPA.
- D. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
 1. Hem-fir or hem-fir (north), Standard or No. 3 Common grade; NLGA, WCLIB, or WWPA.
 2. Spruce-pine-fir (south) or spruce-pine-fir, Standard or No. 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- E. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: DOC PS 1, Exterior, C-C Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.
- 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 to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.
- F. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
- G. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

2.7 METAL FRAMING ANCHORS

- 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. Cleveland Steel Specialty Co.
 - 2. KC Metals Products, Inc.
 - 3. Phoenix Metal Products, Inc.
 - 4. Simpson Strong-Tie Co., Inc.
 - 5. USP Structural Connectors.
- B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
 - 1. Use for interior locations unless otherwise indicated.
- C. Hot-Dip Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.
 - 1. Use for wood-preservative-treated lumber and where indicated.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304.
 - 1. Use for exterior locations and where indicated.

2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
 - 1. Adhesives shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Where wood-preserved-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- C. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- E. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- F. Do not splice structural members between supports unless otherwise indicated.
- G. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) on center.
- H. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- J. Securely attach carpentry work to substrate by anchoring and 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.
3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

- K. Use steel common 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 between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.3 PROTECTION

- A. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

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SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sheathing.
 - 2. Sheathing joint and penetration treatment.

1.3 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 fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.5 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 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory."

2.2 WOOD PANEL PRODUCTS

- A. Plywood: Either DOC PS 1 or DOC PS 2 unless otherwise indicated.
- B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- C. Factory mark panels to indicate compliance with applicable standard.

2.3 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all plywood unless otherwise indicated.

2.4 SHEATHING

- A. Plywood Wall Sheathing: Exterior, Structural I sheathing.
 - 1. Span Rating: Not less than 16/0.
 - 2. Nominal Thickness: Not less than 1/2 inch (13 mm).
- B. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corporation: GlasRoc.
 - b. Georgia-Pacific Building Products: Dens-Glass Gold.
 - c. National Gypsum Company: Gold Bond eXP Extended Exposure Sheathing.
 - d. United States Gypsum Company: Securock.
 - 2. Type and Thickness: Regular, 1/2-inch (13 mm) and Type X, 5/8-inch (15.9 mm) (for fire treated conditions) thick.
 - 3. Size: Minimum 48 by 96 inches (1219 by 2438 mm) for vertical installation.

2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
 - 2. For roof sheathing, provide fasteners per roofing system requirements.
- B. Power-Driven Fasteners: NES NER-272.
- C. Wood Screws: ASME B18.6.1.
- D. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
 - 1. For wall and roof sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
- E. Screws for Fastening Gypsum 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 (0.835 mm) thick, use screws that comply with ASTM C 1002.
2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C 954.

2.6 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 "Joint Sealants."

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."
 3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."
- D. Coordinate 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.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

- F. 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. Nail to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels **1/8-inch (3 mm)** apart at edges and ends.

3.3 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to wood framing with screws.
 - 2. Fasten gypsum sheathing to cold-formed metal framing with screws.
 - 3. Install boards with a **3/8-inch (9.5-mm)** gap where non-load-bearing construction abuts structural elements.
 - 4. Install boards with a **1/4-inch (6.4-mm)** gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.
 - 1. Space fasteners approximately **8 inches (200 mm)** o.c. and set back a minimum of **3/8-inch (9.5 mm)** from edges and ends of boards.
- D. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.

1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8-inch (9.5 mm) from edges and ends of boards.
- E. Seal sheathing joints according to sheathing manufacturer's written instructions.
1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.

END OF SECTION 061600

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior standing and running trim.
 - 2. Wood furring, blocking, shims, and hanging strips for installing interior architectural woodwork items that are not concealed within other construction.
 - 3. Shop priming of interior architectural woodwork.
 - 4. Shop finishing of interior architectural woodwork.
- B. Related Requirements:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing interior architectural woodwork that are concealed within other construction before interior architectural woodwork installation.

1.3 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Wood-Preservative Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained. Include chemical-treatment manufacturer's written instructions for finishing treated material and manufacturer's written warranty.

2. Fire-Retardant Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
 3. Waterborne Treatments: For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
- B. Shop Drawings: For interior architectural woodwork.
1. Include plans, elevations, sections, and attachment details.
 2. Show large-scale details.
 3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
 4. Apply AWI Quality Certification Program label to Shop Drawings.
- C. Samples: For each exposed product and for each color and finish specified, in manufacturer's or fabricator's standard size.
- D. Samples for Initial Selection: For each type of exposed finish.
- E. Samples for Verification: For the following:
1. Lumber for Transparent Finish: Not less than 5 inches (125 mm) wide by 12 inches (300 mm) long, for each species and cut, finished on one side and one edge.
 2. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished interior architectural woodwork.
 3. Lumber and Panel Products with Shop-Applied Opaque Finish: 5 inches (125 mm) wide by 12 inches (300 mm) long for lumber and [8 by 10 inches (200 by 250 mm)] [12 by 12 inches (300 by 300 mm)] for panels, for each finish system and color.
 - a. Finish entire exposed surface.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Fabricator.
- B. Product Certificates: For the following:
1. Composite wood and agrifiber products.
 2. Adhesives.
- C. Evaluation Reports: For fire-retardant-treated wood materials, from ICC-ES.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups of typical interior architectural woodwork as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver interior architectural woodwork until painting and similar finish operations that might damage woodwork have been completed in installation areas. Store woodwork in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Field Measurements: Where interior architectural woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being concealed by construction, and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where interior architectural woodwork is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 INTERIOR ARCHITECTURAL WOODWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
 - 1. Provide inspections of fabrication and installation together with labels and certificates from AWI certification program indicating that woodwork complies with requirements of grades specified.
 - 2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

2.2 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

- A. Grade: Premium.
- B. Wood Species and Cut: See below.
 - 1. Species: Match existing .
 - 2. Cut: Plain sliced/plain sawn.
 - 3. Provide split species on trim that faces areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.
- C. For trim items wider than available lumber, use veneered construction. Do not glue for width.
 - 1. For veneered base, use hardwood lumber core, glued for width.
- D. For base wider than available lumber, glue for width. Do not use veneered construction.

2.3 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.
 - 1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (76 mm) wide.
 - 2. Wood Moisture Content: 5 to 10 percent.

- B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.
 - 1. MDF: ANSI A208.2, Grade 130.
 - 2. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.4 PRESERVATIVE-TREATED-WOOD MATERIALS

- A. Preservative-Treated-Wood Materials: Provide with water-repellent preservative treatment complying with AWPAC N1 (dip, spray, flood, or vacuum-pressure treatment).
 - 1. Preservative Chemicals: 3-iodo-2-propynyl butyl carbamate (IPBC), combined with a compatible EPA-registered insecticide.
 - 2. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.

2.5 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Nailers: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- D. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.

2.6 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate interior architectural woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Edges of Solid-Wood (Lumber) Members: 1/16-inch (1.5 mm) unless otherwise indicated.

2. Edges of Rails and Similar Members more than 3/4-inch (19 mm) thick: 1/8-inch (3 mm).
- C. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
 1. Notify Architect seven (7) days in advance of the dates and times interior architectural woodwork fabrication will be complete.
 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that parts fit as intended and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.

2.7 SHOP PRIMING

- A. Interior Architectural Woodwork for Transparent Finish: Shop seal with stain (if required), other required pretreatments, and first coat of finish as specified in Section 099100 "Painting."
- B. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.

2.8 SHOP FINISHING

- A. General: Finish interior architectural woodwork [with transparent finish] [indicated on Drawings] at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.
- B. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
 1. Backpriming: Apply one (1) coat of sealer or primer, compatible with finish coats, to concealed surfaces of interior architectural woodwork. Apply two coats to end-grain surfaces.
- C. Transparent Finish:
 1. Grade: Premium.
 2. Finish: System - 11, catalyzed polyurethane.

3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
4. Staining: Match existing finish of interior wood, based on Architect's approval.
5. Filled Finish for Open-Grain Woods: After staining, apply wash-coat sealer and allow to dry. Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
6. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition interior architectural woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing interior architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

- A. Grade: Install interior architectural woodwork to comply with same grade as item to be installed.
- B. Assemble interior architectural woodwork and complete fabrication at Project site to the extent that it was not completed in the shop.
- C. Install interior architectural woodwork level, plumb, true in line, and without distortion. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
- D. Scribe and cut interior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Preservative-Treated Wood: Where cut or drilled in field, treat cut ends and drilled holes according to AWPA M4.
- F. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

- G. Anchor interior architectural woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk, and filled flush with interior architectural woodwork.
 - 1. For shop-finished items, use filler matching finish of items being installed.
- H. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 96 inches (2400 mm) long except where shorter single-length pieces are necessary.
 - 1. Scarf running joints and stagger in adjacent and related members.
 - 2. Fill gaps, if any, between top of base and wall with plastic wood filler; sand smooth; and finish same as wood base if finished.
 - 3. Install standing and running trim with no more variation from a straight line than 1/8-inch in 96 inches (3 mm in 2400 mm).
- I. Touch up finishing work specified in this Section after installation of interior architectural woodwork. Fill nail holes with matching filler where exposed.
 - 1. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.
- J. See Section 099100 "Painting" for final finishing of installed interior architectural woodwork not indicated to be shop finished.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective interior architectural woodwork, where possible, to eliminate functional and visual defects. Where not possible to repair, replace interior architectural woodwork. Adjust joinery for uniform appearance.
- B. Clean interior architectural woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064023

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Extruded polystyrene foam-plastic board.
 - 2. Glass-fiber blanket.
 - 3. Mineral-wool blanket.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Low-emitting product certification.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified 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 until just before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

- A. Extruded polystyrene boards in this article are also called "XPS boards." Roman numeral designators in ASTM C 578 are assigned in a fixed random sequence, and their numeric order does not reflect increasing strength or other characteristics.
- B. Extruded Polystyrene Board, Type IV: ASTM C 578, Type IV, 25-psi (173-kPa) minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Owens Corning; Foamular High R CW Plus.
 2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- C. Extruded Polystyrene Board, Type VI: ASTM C 578, Type VI, 25-psi (173-kPa) minimum compressive strength; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
 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. Owens Corning; Foamular 250.
 2. Location of Use: Below grade foundation wall, under slab.
 - a. R-Value/thickness: R=10, 2-inch thickness.
 3. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.2 GLASS-FIBER BLANKET

- A. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:
 1. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.
- B. Glass-Fiber Blanket, Unfaced: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. CertainTeed Corporation.
 - b. Guardian Building Products, Inc.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Owens Corning.
- C. Glass-Fiber Blanket, Foil Faced: ASTM C 665, Type II (nonreflective faced), Class C (faced surface not rated for flame propagation); Category 1 (membrane is a vapor barrier).
 1. Basis-of-Design Product: Subject to compliance with requirements, provide CertainTeed Corporation; CertaPro Commercial Insulation or equal.
 2. 3-1/2 Inch = R-13.
 3. 6-1/4 inch = R-19.

2.3 MINERAL-WOOL BLANKETS

- A. Mineral-Wool Blanket, Unfaced: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
 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. Industrial Insulation Group, LLC (IIG-LLC).
 - b. Roxul Inc.
 - c. Thermafiber, Inc.; an Owens Corning company.

2.4 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate-welded to projecting spindle; capable of holding insulation of specified thickness securely in position 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.
 2. Plate: Perforated, galvanized carbon-steel sheet, 0.030-inch (0.762 mm) thick by 2 inches (50 mm) square.
 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.

2.5 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Glass-Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.
 - 2. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
- C. Supports: Carbon steel spring wires.
 - 1. Thickness: 14 gage, minimum.
 - 2. Cut to support a 16 inch on-center joist spacing with a 45-degree point to grab and hold when released.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or 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.
- 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. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.
- B. Anchor Installation: 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.

3.4 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches (610 mm) 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 042000 "Unit Masonry."

3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 4. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 - 1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).

2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.6 PROTECTION

- A. Protect installed insulation 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 072100

SECTION 075323 - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Adhered EPDM membrane roofing system.
 - 2. Roof insulation.
 - 3. Bellows type roof expansion joints as recommended and warranted by roofing manufacturer.

1.3 DEFINITIONS

- A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing m
- C. anufacturer based on testing and field experience.
- D. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
 - 1. Design roof system to withstand 90 mph wind uplift for peak wind gust.

- E. SPRI Wind Design Standard: Manufacture and install roof-edge flashings tested according to SPRI ES-1.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. 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; 180 deg F, material surfaces.
- G. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low -slope roof products.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Base flashings and membrane terminations.
 - 2. Tapered insulation, including slopes.
 - 3. Roof plan showing orientation of steel roof deck and orientation of membrane roofing and fastening spacings and patterns for mechanically fastened membrane roofing.
 - 4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
- C. Shop Drawings: For roof specialties-roof edge. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:
 - 1. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
 - 2. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.
 - 3. Details of termination points and assemblies, including fixed points.
 - 4. Details of special conditions.
- D. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.
- E. Samples for Verification: For roof-edge flashings made from 12-inch lengths of full-size components including fasteners, cover joints, accessories, and attachments.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and manufacturer.
- B. Manufacturer Certificate: Signed by roofing manufacturer certifying that membrane roofing system complies with requirements specified in "Performance Requirements" Article.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
- D. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For membrane roofing system to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for membrane roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- C. Source Limitations: Obtain components including roof insulation fasteners for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
- D. **Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.**
- E. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- F. Preinstallation Roofing Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's

- representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 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. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 5. Review structural loading limitations of roof deck during and after roofing.
 6. Review base flashings, special roofing details, roof drainage, roof edging, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 7. Review governing regulations and requirements for insurance and certificates if applicable.
 8. Review temporary protection requirements for roofing system during and after installation.
 9. Review roof observation and repair procedures after roofing installation.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- E. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

- F. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.10 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, and other components of membrane roofing system.
 - 2. Warranty Period: Twenty (20) years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering Work of this Section, including all components of membrane roofing system such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
 - 1. Warranty Period: Two (2) years from date of Substantial Completion.
- C. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No.8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: Twenty (20) years from date of Substantial Completion.
- D. Work associated with existing roof shall not void the existing roof warranty and shall be done by a contractor certified by the existing roof system manufacturer.

PART 2 - PRODUCTS

2.1 EPDM MEMBRANE ROOFING

- A. EPDM: ASTM D 4637, Type II, scrim, or fabric internally-reinforced, uniform, flexible EPDM sheet.
 - 1. Basis of Design 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. Firestone Building Products.
 - b. Carlisle.
 - c. Johns Manville.
 - 2. Thickness: 60 mils, nominal.
 - 3. Exposed Face Color: Black.

2.2 AUXILIARY MEMBRANE ROOFING MATERIALS

- A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
 - 2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Gypsum Board and Panel Adhesives: 50 g/L.
 - c. Multipurpose Construction Adhesives: 70 g/L.
 - d. Fiberglass Adhesives: 80 g/L.
 - e. Single-Ply Roof Membrane Adhesives: 250 g/L.
 - f. Single-Ply Roof Membrane Sealants: 450 g/L.
 - g. Non-membrane Roof Sealants: 300 g/L.
 - h. Sealant Primers for Nonporous Substrates: 250 g/L.
 - i. Sealant Primers for Porous Substrates: 775 g/L.
 - j. Other Adhesives and Sealants: 250 g/L.
- B. Sheet Flashing: 60-mil- thick EPDM, partially cured or cured, according to application.
- C. Membrane Bonding Adhesive: Manufacturer's standard.
- D. Insulation Low-Rise, Urethane, Adhesive: System manufacturer's standard spray-applied, low-rise, two-component urethane adhesive.

- E. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- wide minimum, butyl splice tape with release film.
- F. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing.
- G. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1-inch x 1/8-inch thick; with anchors.
- H. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1-inch wide x 0.05-inch thick, pre-punched.
- I. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.
- J. Miscellaneous Accessories: Provide pourable sealers, pre-formed cone, and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, expansion joints, and other accessories.

2.3 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by EPDM membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation.
- B. Extruded Polystyrene (XPS) Board Insulation: ASTM C578, Type IV, Class I, Grade 3 (minimum 25 psi), felt or glass-fiber mat facer on both major surfaces.
 - 1. Maximum Thickness: 6 inches (152.4 mm).
 - 2. R-value: 5.0 per inch (ASTM C518).
 - 3. Maximum Density: 1.45 pcf.
 - 4. Basis-of-Design Product: Owens Corning, FOAMULAR ThermaPink 25.
 - a) Acceptable manufacturer: Kingspan GreenGuard, Type IV XPS Insulation Board.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4-inch per 12 inches (1:48) unless otherwise indicated.

2.4 INSULATION ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.

- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
- C. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

2.5 SUBSTRATE BOARD (Cover Board)

- A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Georgia-Pacific Building Products; Dens Deck or equal.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate panel to roof deck.

2.6 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
 - 1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
 - 4. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 5. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.

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

3.2 INSTALLATION, GENERAL

- A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.
 - 1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 - 3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 - 4. Torch cutting of roof specialties is not permitted.
 - 5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of self-adhering, high-temperature sheet underlayment.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
 - 1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise shown on Drawings.
 - 2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that will penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal joints with elastomeric sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.3 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove

sharp projections.

- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of six (6) inches in each direction.
 - 1. Where installing composite and non-composite insulation in two or more layers, install non-composite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4-inch with insulation.
 - 1. Cut and fit insulation within 1/4-inch of nailers, projections, and penetrations.
- G. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.

2. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
 3. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 4. Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing, and maintaining insulation in place.
 5. Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing, and maintaining insulation in place.
- H. Existing Roof Decks: Verify deck materials and provide a system option for insulation fastening.

3.5 ADHERED MEMBRANE ROOFING INSTALLATION

- A. Adhere membrane roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
- B. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
- C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
- E. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeters.
- F. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
- G. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
 1. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
- H. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap

sealant and seal exposed edges of membrane roofing terminations.

- I. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
- J. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

3.6 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.7 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.8 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C.

- D. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
- E. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- F. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- G. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

3.9 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS **<Insert name>** of **<Insert address>**, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
 - 1. Owner: **<Insert name of Owner.>**
 - 2. Address: **<Insert address.>**
 - 3. Building Name/Type: **<Insert information.>**
 - 4. Address: **<Insert address.>**
 - 5. Area of Work: **<Insert information.>**
 - 6. Acceptance Date: **<Insert date.>**
 - 7. Warranty Period: **<Insert time.>**
 - 8. Expiration Date: **<Insert date.>**
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work
- D. and as are necessary to maintain said work in a watertight condition.
- E. This Warranty is made subject to the following terms and conditions:
 - 1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. Lightning;
 - b. Peak gust wind speed exceeding 90 mph;

- c. Fire;
 - d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. Faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. Vapor condensation on bottom of roofing; and
 - g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
- 2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
 - 3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
 - 4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alteration
 - 5. s, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Inst
 - 6. aller, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
 - 7. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall
 - 8. become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
 - 9. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
 - 10. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract

Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

END OF SECTION 075323

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SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Manufactured through-wall flashing with snaplock receiver.
 - 2. Manufactured reglets with counterflashing.
 - 3. Formed Custom Roof Edge.

1.3 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
 - 3. Review requirements for insurance and certificates if applicable.
 - 4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.5 ACTION SUBMITTALS

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

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
 - B. Shop Drawings: For sheet metal flashing and trim.
 1. Include plans, elevations, sections, and attachment details.
 2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
 3. Include identification of material, thickness, weight, and finish for each item and location in Project.
 4. Include details for forming, including profiles, shapes, seams, and dimensions.
 5. Include details for joining, supporting, and securing, including layout, and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 6. Include details of termination points and assemblies.
 7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
 8. Include details of special conditions and Custom Roof Edges.
 9. Include details of connections to adjoining work.
 - C. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.
 - D. Samples for Verification: For each type of exposed finish.
 1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 2. Custom Roof Edges: 12 inches (300 mm) long and in required profile. Include fasteners and other exposed accessories.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Sample Warranty: For special warranty.
- 1.7 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical custom roof edge, approximately 10 feet (3.0 m) long, including supporting construction cleats, seams, attachments and accessories.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.10 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No.8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: Twenty (20) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 (Z275) coating designation; prepainted by coil-coating process to comply with ASTM A 755/A 755M.
 - 1. Surface: Smooth, flat.
 - 2. Exposed Coil-Coated Finish:
 - a. Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes 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.
 - 3. Color: As selected by Architect from manufacturer's full range.
 - 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

2.3 UNDERLAYMENT MATERIALS

- A. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - 2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, non-toxic, non-staining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- D. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Epoxy Seam Sealer: Two-part, non-corrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

2.5 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with interlocking counterflashing on exterior face, of same metal as reglet.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Fry Reglet Corporation; 'MA-4' Masonry Reglet, 4-inch top flange.
 - 2. Material: Galvanized steel, 0.022 inch (0.56 mm) thick.

3. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
4. Accessories:
 - a. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
5. Finish: With manufacturer's standard color coating, color to be selected by Architect.

2.6 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 2. Obtain field measurements for accurate fit before shop fabrication.
 3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- C. Custom Roof Edges: Fabricate to configurations detailed with prefinished metal, metallic Kynar 500 finish.
- D. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 1. Use lapped expansion joints only where indicated on Drawings.
- E. Sealant Joints: Where movable, non-expansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- F. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

- G. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 3. Space cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 - 4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
 - 5. Torch cutting of sheet metal flashing and trim is not permitted.
 - 6. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
 - 1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
 - 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.3 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.
- C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints minimum of 4 inches (100 mm). Secure in waterproof manner by means of unless otherwise indicated.

3.4 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Reglets: Installation of reglets is specified in Section 042000 "Unit Masonry."

3.5 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4-inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean off excess sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have
- E. deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

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SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in horizontal assemblies.
 - 3. Penetrations in smoke barriers.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

- a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."
 - 3) FM Global in its "Building Materials Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
 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. 3M Fire Protection Products.
 - b. A/D Fire Protection Systems Inc.
 - c. Hilti, Inc.
 - d. RectorSeal.
 - e. Specified Technologies, Inc.
 - f. Tremco, Inc.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
 1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
 1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
 2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
 3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at and no more than 50-cfm (0.024-cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.
- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.
- F. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content:
 1. Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
 1. Permanent forming / damming / backing materials.
 2. Substrate primers.
 3. Collars.
 4. Steel sleeves.

2.3 FILL MATERIALS

- A. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- B. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- C. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
- D. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- E. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- F. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.

- G. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- H. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
- I. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

2.4 MIXING

- A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.

- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items to achieve required fire-resistance ratings.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- B. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

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SECTION 078443 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Joints in or between fire-resistance-rated constructions.
 - 2. Joints in smoke barriers.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
 - 2. instance-rated assembly.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each joint firestopping system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global
- B. In accordance with FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

- A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Joint firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."

2.2 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Basis of Design: 3M Fire Protection Products.
- C. 3M Fire Barrier Sealant FD 150+: Single-part, water-based sealant. Sag-resistant, low-shrinkage, low VOC, UL 2079.
 - 1. Fire Resistance: For use in 1-, 2-, 3-, or 4-hour fire-rated systems.
 - 2. Location: For use at top-of-wall, bottom-of-wall, wall-to-wall and floor-to-floor.
 - 3. Compression/Extension Recovery: +/- 19 percent of original joint width.
 - 4. Meets optional L rating requirements.
- D. 3M Fire Barrier Water Tight Sealant 1000 NS: Single-part, non-slump elastomeric silicone sealant. Sag-resistant, low VOC, UL 2079.
 - 1. Fire Resistance: For use in 1-, 2-, 3-, or 4-hour fire rated systems.
 - 2. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
 - 3. Location: For use at top-of-wall, bottom-of-wall, wall-to-wall, floor-to-floor, floor-to-wall, and perimeter joints.
 - 4. Compression/Extension Recovery: +/- 15 percent of original joint width.
- E. 3M Fire Barrier Water-Tight Sealant 1003 SL: Single-part, self-leveling elastomeric silicone sealant. Sag-resistant, low VOC, UL 2079.
 - 1. Fire Resistance: For use in 1-, 2-, 3-, or 4-hour fire rated systems.
 - 2. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
 - 3. Location: For use at top-of-wall, bottom-of-wall, floor-to-wall, and floor-to-floor joints.
 - 4. Compression/Extension Recovery: +/- 15 percent of original joint width.
- F. 3M Fire Barrier Sealant 2000 NS: Single-part, non-slump elastomeric silicone sealant. Sag-resistant, low VOC, UL 2079.
 - 1. Fire Resistance: For use in 1-, 2-, 3-, or 4-hour fire rated systems.
 - 2. Service Flexibility: Accommodate vibration from normal building movement.
 - 3. Location: For use at top-of-wall, bottom-of-wall, wall-to-wall, floor-to-wall, floor-to-floor, and perimeter joints.
 - 4. Compression/Extension Recovery: +/- 31 percent of original joint width.

- G. 3M Fire Barrier Sealant 2000+: Silicone Sealant: Single-part, elastomeric silicone sealant. Sag-resistant, low VOC, UL 2079.
 - 1. Fire Resistance: For use in 1-, 2-, 3-, or 4-hour fire rated systems.
 - 2. Compression/Extension Recovery: +/- 13 percent of original joint width.
 - 3. Location: For use at top-of-wall, bottom-of-wall, wall-to-wall, floor-to-wall and floor-to-floor joints.
- H. 3M FireDam Spray 200: Water-based, paintable, low VOC, freeze/thaw resistant spray applied fire resistive product. Applied with conventional airless spray equipment, UL 2079.
 - 1. Fire Resistance: For use in 1-, 2-, 3-, or 4-hour fire rated systems.
 - 2. Compression/Extension Recovery: +/- 50 percent of joint width.
 - 3. Location: For use at head-of-wall, wall-to-wall, floor-to-floor, bottom-of-wall, floor-to-wall, and perimeter joints.
- I. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- J. VOC Content: Fire-resistive joint system sealants shall comply with the following limits for VOC content:
 - 1. Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- K. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Before installing fire-resistive joint systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
 - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install elastomeric fill materials for fire-resistive joint systems by proven techniques to produce the following results:
 - 1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
 - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm)

of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2393.
- B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.
- C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

- A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 078443

SECTION 079200 – JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-staining silicone joint sealants.

1.3 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch (13 mm) wide joints formed between two)2) 6-inch (150 mm) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint Sealant Schedule: Include the following information:
 - 1. Joint sealant application, joint location, and designation.
 - 2. Joint sealant and backer rod compatibility.
 - 3. Joint sealant manufacturer and product name.
 - 4. Joint sealant formulation.
 - 5. Joint sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.

- B. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.7 FIELD CONDITIONS

- A. 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 joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

- A. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Five (5) years from Date of Substantial Completion.
- B. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 - 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 - 2. Disintegration of joint substrates from causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. 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 joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:
 - 1. Architectural sealants shall have a VOC content of 250 g/L or less.
 - 2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 NON-STAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.
- B. Silicone, Non-staining, S, NS, 50, NT: Non-staining, single-component, non-sag, plus 50 percent and minus 50 percent movement capability, non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 - 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. Dow Corning Corporation; 756 SMS.
 - b. GE Construction Sealants; Momenive Performance Materials Inc.; Silpruf NB.
 - c. Pecora Corporation; 898NST.
 - d. Tremco Incorporated; Spectrem 3.

2.3 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

- a. BASF Corporation-Construction Systems; MasterSeal 920 & 921 (Pre-2014: Sonolastic Backer Rod.)
- B. Cylindrical Sealant Backings: ASTM C 1330, or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- 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. Provide self-adhesive tape where applicable.

2.4 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 to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

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 performance of the Work.
- 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, 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 after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
 3. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where recommended by joint sealant manufacturer or as indicated by 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 or primer 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 in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind 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 backs of joints.

- E. Install sealants using proven techniques that 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 in 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 in subparagraphs 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 sealant from surfaces adjacent to joints.
 - 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 profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.4 CLEANING

- A. Clean off excess sealant 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, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces.
 - 1. Joint Locations:
 - a. Control and expansion joints in unit masonry.
 - b. Joints between different materials listed above.
 - c. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
 - d. Control and expansion joints in ceilings and other overhead surfaces.

- e. Other joints as indicated on Drawings.
- 2. Joint Sealant: Silicone, non-staining, S, NS, 50, NT.
- 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

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SECTION 079219 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes acoustical joint sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each acoustical joint sealant.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Acoustical-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each kind of acoustical joint sealant, for tests performed by a qualified testing agency.
- B. Sample Warranties: For special warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E 90.

- B. VOC Content of Interior Sealants: Sealants and sealant primers shall comply with the following:
 - 1. Acoustical sealants and sealant primers shall have a VOC content of 250 g/L or less.
- C. Low-Emitting Interior Sealants: Acoustical sealants and sealant primers shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard non-sag, paintable, non-staining latex acoustical sealant complying with ASTM C 834.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide United States Gypsum Company; SHEETROCK Acoustical Sealant.
 - 2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

2.3 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.
- B. Cleaners for Non-porous 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 non-porous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, 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. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer. 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 or primer 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 ACOUSTICAL JOINT SEALANTS

- A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.
- B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C 919, ASTM C 1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.
- C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.4 CLEANING

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

3.5 PROTECTION

- A. Protect acoustical 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,

remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079219

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Access doors and frames for partitions and ceilings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Detail fabrication and installation of access doors and frames for each type of substrate.
- C. Samples: For each door face material, at least 3 by 5 inches (75 by 125 mm) in size, in specified finish.
- D. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
2. NFPA 288 for fire-rated access door assemblies installed horizontally.

2.2 ACCESS DOORS AND FRAMES FOR PARTITIONS AND CEILINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Access Panel Solutions.
 2. Babcock-Davis.
 3. JL Industries, Inc.; a division of the Activar Construction Products Group.
 4. Larsens Manufacturing Company.
 5. Milcor; Commercial Products Group of Hart & Cooley, Inc.
 6. Nystrom, Inc.
- B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.
- C. Flush Access Doors with Exposed Flanges in CMU:
1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
 2. Locations: Partition and ceiling.
 3. Door Size: As indicated.
 4. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16-gage.
 - a. Finish: Factory prime, field paint.
 5. Toilet Rooms and Kitchen: Stainless-Steel Sheet for Door: Nominal 0.062 inch (1.59 mm), @ 16-gage.
 - a. Finish: No. 4.
 6. Frame Material: Same material, thickness, and finish as door.
 7. Hinges: Manufacturer's standard.
 8. Hardware: Lock.
- D. Flush Access Doors with Concealed Flanges in GWB:
1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board or plaster beads per location for concealed flange installation.
 2. Locations: Partition and ceiling.
 3. Door Size: As indicated.
 4. Uncoated Steel Sheet for Door: Nominal 0.060-inch (1.52 mm), 16-gage.
 - a. Finish: Factory prime, field paint.
 5. Toilet Rooms and Kitchen: Stainless-Steel Sheet for Door: Nominal 0.062-inch (1.59 mm), 16-gage.
 - a. Finish: No. 4.
 6. Frame Material: Same material and thickness as door.

7. Hinges: Manufacturer's standard.
8. Hardware: Lock.

E. Fire-Rated, Flush Access Doors with Exposed Flanges in CMU:

1. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
2. Locations: Partition and ceiling.
3. Fire-Resistance Rating: Not less than that of adjacent construction.
4. Temperature-Rise Rating: 450 deg F (250 deg C) at the end of thirty (30) minutes.
5. Uncoated Steel Sheet for Door: Nominal 0.036-inch (0.91 mm), 20-gage.
 - a. Finish: Factory prime, field paint.
6. Toilet Rooms and Kitchen: Stainless-Steel Sheet for Door: Nominal 0.038-inch (0.95 mm), 20-gage.
 - a. Finish: No. 4.
7. Frame Material: Same material, thickness, and finish as door.
8. Hinges: Manufacturer's standard.
9. Hardware: Latch.

F. Fire-Rated, Flush Access Doors with Concealed Flanges in GWB:

1. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide frame with gypsum board and plaster beads, depending on location, for concealed flange installation.
2. Locations: Partition and ceiling.
3. Fire-Resistance Rating: Not less than that of adjacent construction.
4. Temperature-Rise Rating: 450 deg F (250 deg C) at the end of thirty (30) minutes.
5. Uncoated Steel Sheet for Door: Nominal 0.036 inch (0.91 mm), 20-gage.
 - a. Finish: Factory prime, field paint.
6. Frame Material: Same material, thickness, and finish as door.
7. Hinges: Manufacturer's standard.
8. Hardware: Lock.

G. Hardware:

1. Latch: Cam latch operated by flush key.
2. Lock: Cylinder, coordinate with hardware master keying.

2.3 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 316. Remove tool and die marks and stretch lines or blend into finish.
- C. Frame Anchors: Same type as door face.
- D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 - 1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
 - 2. Provide mounting holes in frames for attachment of units to metal or wood framing.
 - 3. Provide mounting holes in frame for attachment of masonry anchors.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 - 1. For cylinder locks, furnish two keys per lock and key all locks alike.

2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

- D. Steel and Metallic-Coated-Steel Finishes in all locations unless otherwise indicated:
 - 1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
 - 2. Field finish paint.
- E. Stainless-Steel Finishes in Toilet Rooms, Kitchens, Custodian Closets
 - 1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 - 2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - c. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING

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

END OF SECTION 083113

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SECTION 089119 - FIXED LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fixed, extruded-aluminum and/or formed-metal louvers.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axes of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
 2. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.
- D. Delegated-Design Submittal: For louvers indicated to comply with structural performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.
- B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without

permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- E. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal, Drainable-Blade Louver:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; Model A4097.
 2. Louver Depth: 4 inches (100 mm).
 3. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm).
 4. Mullion Type: Exposed.
 5. Finish: As selected by Architect from manufacturer's full range.
 6. Louver Performance Ratings:
 - a. Free Area: Not less than 8.0 sq. ft. (0.74 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
 7. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
- B. Vertical, Storm Resistant Louver:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties; Model RS-5605.
 2. Louver Depth: 5 inches..
 3. Frame and Blade Nominal Thickness: 0.125 inch.
 4. Finish: As selected by Architect from manufacturer's full range.
 5. Louver Performance Ratings:
 - a. Free Area: Not less than 9.0 sq. ft. for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
 6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
 - 1. Screen Location for Fixed Louvers: Interior face.
 - 2. Screening Type: Bird screening except where insect screening is indicated.
- B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches (150 mm) from each corner and at 12 inches (300 mm) o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
 - 1. Metal: Extruded-aluminum.
 - 2. Finish: Mill finish.
- D. Louver Screening for Aluminum Louvers:
 - 1. Bird Screening: Flattened, expanded aluminum, 5/8 by 0.050 inch thick.
Insect Screening: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm) wire or Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm) wire.

2.5 BLANK-OFF PANELS

- A. Insulated, Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.
 - 1. Thickness: 2 inch.
 - 2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch (0.81-mm) nominal thickness.
 - 3. Insulating Core: Rigid, glass-fiber-board insulation or extruded-polystyrene foam.
 - 4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch (2.03-mm) nominal thickness, with corners mitered and with same finish as panels.
 - 5. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
 - 6. Panel Finish: Same type of finish applied to louvers.
 - 7. Attach blank-off panels with sheet metal screws.

2.6 MATERIALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.
- B. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 3. For color-finished louvers, use fasteners with heads that match color of louvers.
- C. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.7 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
1. Frame Type: Channel unless otherwise indicated.
- D. Include supports, anchorages, and accessories required for complete assembly.
- E. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.
1. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
- F. Provide subsills made of same material as louvers for recessed louvers.
- G. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.8 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: Custom Color to match metal wall panels. Metal wall panel basis of design is MBCI, colors are either MBCI Silver Metallic or MBCI Aegean Blue, depending on location.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, 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. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying

a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units, and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 089119

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SECTION 092116.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Gypsum board shaft wall assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: As indicated.
- B. STC Rating: As indicated.
- C. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
 - 1. Depth: 2-1/2 inches (64 mm).
 - 2. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm) (20 gage).
- D. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches (51 mm) long and matching studs in depth.
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
- E. Firestop Tracks: Provide firestop track at head of shaft wall on each floor level.
- F. Room-Side Finish: As indicated.
- G. Shaft-Side Finish: Gypsum shaftliner board, moisture- and mold-resistant Type X.
- H. Insulation: Sound attenuation blankets.

2.3 PANEL PRODUCTS

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.

1. Products: Subject to compliance with requirements, provide the following:
 - a. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner XP.
2. Thickness: 1 inch (25.4 mm).
3. Long Edges: Double bevel.
4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

C. Gypsum Board: As specified in Section 092900 "Gypsum Board."

2.4 NON-LOAD-BEARING STEEL FRAMING

- A. Steel Framing Members: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 1. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- B. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Fire Trak Corp; Fire Trak System attached to studs with Fire Trak Posi Klip.

2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with manufacturer's written recommendations.
- B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
- D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
 1. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing according to ASTM E 488 conducted by a qualified testing agency.
 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain,

without failure, a load equal to 10 times design load, as determined by testing according to ASTM E 1190 conducted by a qualified testing agency.

- E. Sound Attenuation Blankets: As specified in Section 092900 "Gypsum Board."
- F. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to which gypsum board shaft wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in Section 078100 "Applied Fireproofing."
- B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION

- A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.
- B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.

- C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
 - 1. Reinforcing: Where handrails directly attach to gypsum board shaft wall assemblies, provide galvanized steel reinforcing strip with 0.033-inch (0.84-mm) minimum thickness of base metal (uncoated), accurately positioned and secured behind at least one layer of face panel.
- D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
- E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.
- F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- G. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
- H. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.
- I. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8-inch (3 mm) from the plane formed by faces of adjacent framing.

3.4 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092116.23

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SECTION 092216 – NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes non-load-bearing steel framing members for the following applications:
 - 1. Interior framing systems (e.g., supports for partitions, framed soffits, furring, etc.).
 - 2. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

PART 2 - PRODUCTS

2.1 NON-LOAD-BEARING STEEL FRAMING, GENERAL

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G60, hot-dip galvanized, unless otherwise indicated.

2.2 SUSPENSION SYSTEM COMPONENTS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch diameter wire, or double strand of 0.0475-inch diameter wire.
- B. Hanger Attachments to Concrete:
 - 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
 - a. Type: Cast-in-place anchor, designed for attachment to concrete forms; postinstalled, chemical anchor; and post installed, expansion anchor.
 - 2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
- E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.
 - 1. Depth: 2 inches.
- F. Furring Channels (Furring Members):
 - 1. Cold-Rolled Channels: 0.0538 inch bare-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
 - 2. Steel Studs: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 18 Gauge (0.0403 inch).
 - b. Depth: As indicated on Drawings.
 - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base Metal Thickness: 20 Gauge (0.0359 inch).
 - 4. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical or hat shaped.
- G. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Armstrong World Industries, Inc.; Drywall Grid Systems.
- b. Chicago Metallic Corporation; Drywall Furring System.
- c. USG Corporation; Drywall Suspension System.

2.3 STEEL FRAMING FOR FRAMED ASSEMBLIES

- A. Steel Studs and Runners: ASTM C 645.
 1. Minimum Base-Metal Thickness: 18 Gauge (0.0403 inch).
 2. Depth: As indicated on Drawings.
- B. Slip-Type Head Joints: Where indicated, provide one of the following:
 1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch-deep flanges in thickness not less than indicated for studs, installed with studs friction-fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
 2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
 3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Steel Network Inc. (The); VertiClip SLD and/or VertiTrack VTD Series.
 - 2) Superior Metal Trim; Superior Flex Track System (SFT).
- C. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
 - b. Metal-Lite, Inc.; The System.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 1. Minimum Base-Metal Thickness: 20 Gauge (0.0359 inch).

- E. Cold-Rolled Channel Bridging: 0.0538 inch bare-steel thickness, with minimum 1/2-inch-wide flanges.
 - 1. Depth: 1-1/2 inches.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base Metal Thickness: 20 Gauge (0.0359 inch).
 - 2. Depth: 7/8-inch.
- G. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
 - 1. Configuration: Asymmetrical or hat shaped.
- H. Cold-Rolled Furring Channels: 0.0538 inch bare-steel thickness, with minimum 1/2-inch-wide flanges.
 - 1. Depth: 3/4-inch.
 - 2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 20 Gauge (0.0359) inch.
 - 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch diameter wire, or double strand of 0.0475-inch- diameter wire.
- I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare-metal thickness of 24 Gauge (0.0239 inch), and depth required to fit insulation thickness indicated. Provide custom sized furring in 1/2", 3/4" or 1" sizes to meet specific assembly thicknesses shown on details in the contract documents.
- J. Stud Wall Reinforcing Steel (Tube and Base Plate):
 - 1. Provide heavy gauge steel manufactured product for reinforcing:
 - a. Low walls of metal framing that are 3'-0" to 6'-0" in height.
 - b. Metal framing at door jambs and strikes.
 - 2. Steel base plate metal thickness: 3/8-inch.
 - 3. Steel base plate dimensions: 3 inches x 8 inches with three holes for 1/2-inch diameter bolts.
 - 4. Size of vertical steel tube: 2-inch x 1-inch x 14 Gauge steel tube.
 - 5. Height of vertical steel tube: 34-1/2 inches.
 - 6. Vertical steel tube location on plate: Tube is at one end of base plate to brace low wall and offset on plate to allow conduits to pass by within reinforced low wall.
 - 7. Spacing for 3 ft high low wall: 6 feet on center.
 - 8. Spacing for 4 ft. high low wall: 4 feet on center.
 - 9. Spacing for 5 ft. high low wall: 4 ft. on center.
 - 10. Spacing for 6 ft. high low wall: 4 ft. on center.

11. Base plate is secured to concrete floor slab with 1/2-inch diameter steel bolt fasteners with 3½-inch minimum embedment.
12. Manufacturer and Product:
 - a. NoFlex, Inc; NoFlex - The Low Wall Support Solution (Basis-of-Design)
NoFlex, Inc.
9121 Atlanta Avenue, Suite 333
Huntington Beach, California 92646
Ph: (800) 720-1994
Website: www.noflex.com
 - b. Approved equal.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Partitions: Provide the following:
 1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate

- for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 5. Do not attach hangers to steel roof deck.
 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.5 INSTALLING FRAMED ASSEMBLIES

- A. Where studs are installed directly against exterior masonry partitions or dissimilar metals at exterior partitions, install isolation strip between studs and exterior partition.
- B. Install studs so flanges within framing system point in same direction.
1. Space studs as follows:
 - a. Single-Layer Application: 16 inches o.c., unless otherwise indicated.
 - b. Multilayer Application: 16 inches o.c., unless otherwise indicated.
- C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb, unless otherwise indicated.

- b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- D. Direct Furring:
 - 1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- E. Z-Furring Members:
 - 1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches o.c.
 - 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
 - 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
 - 4. Install custom furring over support framing as shown in the details in the contract documents.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8-inch from the plane formed by faces of adjacent framing.

END OF SECTION 092216

SECTION 090120 – PATCHING LARGE HOLES IN PLASTER WITH PLASTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The procedures include general guidelines offered by GSA (US Government Services Administration) to follow when restoring plaster in historic buildings. It identifies specific design issues and outlines recommended installation solutions that have the least visual or physical impact on the historic materials. This procedure includes guidance on repair of large plaster holes greater than 4-inches in diameter. When larger sections of plaster are missing, drywall patches may be used as a base.
- B. Related Requirements:
 - 1. Division 09: Patching Small Holes in Cracks & Plaster.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
- B. Sustainable Submittals:
- C. Product Data: for adhesives, documentation including printed statement of VOC content.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports:
 - 1. Expansion anchors.
 - 2. Metal framing anchors.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials from weather in waterproof enclosure. Provide for air circulation around materials.

1.6 QUALITY ASSURANCE

- A. These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the State Historic Preservation Officer (SHPO).

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Drywall and joint compound.
- B. Nails and screws.
- C. Joint tape (cloth mesh preferred).

2.2 EQUIPMENT

- A. 6-inch taping knife.
- B. 12-inch taping knife.
- C. Float.
- D. Hawk.
- E. Sanding sponge (medium fine grit).
- F. Stiff putty knife.
- G. Goggles, work gloves, and dust mask.
- H. Hammer and cold chisel.
- I. Needle nose pliers and wire cutter.
- J. Screw gun and drill.
- K. Spray bottle and drop cloths.
- L. Tin snips.
- M. Vacuum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Determine the extent of damaged plaster. Look for:
1. Holes.
 2. Water Stains: Brownish rings on the plaster, especially the ceilings, indicate that the plaster has been wet. If the water was stopped quickly, the surface may only need to be sealed with pigmented shellac to prevent the stain from bleeding through the new paint or wallpaper. However, if the leak continued for a long period, the plaster will need to be replaced, and will often have a powdery appearance.
 3. Chipping, flaking and delamination of plaster due to water infiltration.

3.2 EXECUTION / INSTALLATION / APPLICATION

- A. Removing Deteriorated Plaster:
1. Remove loose plaster from the walls by hand (or flat pry bar may also be helpful in removing plaster that is difficult to remove by hand).
 2. To remove sound plaster, for whatever reason, drill holes in the line of cut with a carbide drill bit; Holding the chisel at a shallow angle, carefully cut directly from hole to hole with a cold chisel; Cut the resulting plaster free from the lath by chipping the keys from the side.
 3. Cut the plaster back to the nearest studs to make a regular opening, and re-secure the lath with drywall nails.
 4. Use plaster washers and wood screws to re-secure weakly-keyed areas of sound plaster to the wall or ceiling.
 5. Knock any plaster stuck between the lath back into the wall cavity.
 6. Vacuum all dust, loose plaster, and other debris from the hole with a shop-vac, or sweep it out with an old paintbrush.
- B. Making a Sheetrock Patch
1. Shim the Sheetrock as required to bring it up flush with the surface of the adjacent plaster.
 2. Cut a Sheetrock patch to fit neatly in the opening.
 3. Nail or screw the sheetrock in place; nail heads or screw heads should be set slightly below the surface of the Sheetrock, but without breaking the paper.
 4. Using the 6-inch taping knife, fill the joint between the Sheetrock and the plaster with a small amount of joint compound.
 5. Apply a fairly smooth, heavy coat of compound over the joint a little wider than the tape width.

6. Center the joint tape over the length of the joint; Hold the 6-inch taping knife at a 45-degree angle and press the tape into the compound; Smooth out any air pockets under the tape.
7. Apply a thin layer of compound over the tape and apply a first coat of compound to nails or screws.
8. Knock off any ridges or pimples that develop from shrinkage and cracking in the compound.
9. Apply the second coat of compound with the 6-inch taping knife and feather the edges out 6-8 inches; Scrape off any ridges or bumps.
10. When the second coat is dry, apply the third coat of compound with the 12 inch taping knife and feather the edges out 12-14 inches.
11. Touch up low spots with additional compound or high spots by light sanding with a wet sanding sponge.

3.3 WASTE MANAGEMENT

A. Coordinate with Division 01.

1. Separate and recycle cut-offs and waste materials and material packaging in accordance with Waste Management Plan and to the maximum extent economically feasible and place in designated areas for recycling.
2. Set aside and protect materials suitable for reuse and/or remanufacturing.
3. Separate and fold up metal banding; flatten and place along with other metal scrap for recycling in designated area.

END OF SECTION 090120

SECTION 092320 – PATCHING SMALL HOLES & CRACKS IN PLASTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The procedures include general guidelines offered by GSA (US Government Services Administration) to follow when restoring plaster in historic buildings. It identifies specific design issues and outlines recommended installation solutions that have the least visual or physical impact on the historic materials. This procedure includes guidance on repair of patching small chips, cracks, or depressions in plaster surfaces.
- B. Related Requirements:
 - 1. Section 092310 Patching Large Holes & Cracks in Plaster.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
- B. Sustainable Submittals:
- C. Product Data: for adhesives, documentation including printed statement of VOC content.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports:
 - 1. Expansion anchors.
 - 2. Metal framing anchors.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials from weather in waterproof enclosure. Provide for air circulation around materials.

1.6 QUALITY ASSURANCE

- A. These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the local preservation office or State Historic Preservation Officer (SHPO).

1.7 REFERENCES

- A. American National Standards Institute (ANSI) Standard Specifications: ANSI, 1430 Broadway, New York, NY 10018.
- B. American Society for Testing and Materials (ASTM) Standard Specifications: ASTM, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. U.S. Gypsum Association 810 First Street NE, #510 Washington, DC 20002 202/289-5440, FAX 202/289-3707

2.2 MATERIALS

- A. Gypsum Plaster Materials:
 - 1. General: gypsum plastering materials shall conform to ANSI A42.1. Provide neat or ready-mixed materials at installer's option unless indicated otherwise.
 - 2. Base coat plaster: Perlite gypsum plaster such as "Structo-Lite" (U.S. Gypsum Association), or approved equal.
 - 3. Base coat aggregate: Sand.
 - 4. Finish coat plaster: Keene's cement.
 - 5. Finishing lime: Installer's option for type.
- B. Bonding Materials: Bonding agent shall conform to ASTM C631.

2.3 EQUIPMENT

- A. Joint knife.
- B. Sponge or heavy-nap cloth.
- C. Crack widener or triangular can opener.

- D. Stiff bristle brushes.
- E. Hawk.
- F. Slicker (flexible straight-edge).
- G. Plasterer's trowel.
- H. Margin trowel.
- I. Mortarboard and mud pan.
- J. Pointing trowel.

PART 3 - EXECUTION

3.1 EXECUTION, INSTALLATION, APPLICATION

- A. Scrape loose or damaged finish plaster and peeling paint from surface with chisel or joint knife. Remove material where required to enlarge cracks, chips, holes, etc. to at least 1/2 inch across and undercut to improve bonding of new material.
- B. Brush or vacuum surface to remove dust and debris.
- C. Moisten the surface by lightly spraying a fine mist of clean water from a spray bottle.
- D. Apply skim finish coat over low areas to bring entire finished surface out flush with the projecting firm and sound layers of adjacent plaster or paint. Form plaster as required to match original configuration and design or ornamental plaster.
- E. Once dry, sand by hand to produce a surface without bumps, cracks, or depressions, ready to receive finish treatment.

3.2 ADJUSTING/CLEANING

- A. Upon completion of this work, all floors, walls, and other adjacent surfaces that are stained, marred, or otherwise damaged by work in this procedure shall be cleaned and repaired and all work and the adjacent areas shall be left in a clean and perfect condition.
- B. All completed work shall be adequately protected from damage by subsequent building operations and effects of weather. Protection shall be by methods recommended by the manufacturer of installed materials and as approved by Architect.

3.3 WASTE MANAGEMENT

A. Coordinate with Division 01.

1. Separate and recycle cut-offs and waste materials and material packaging in accordance with Waste Management Plan and to the maximum extent economically feasible and place in designated areas for recycling.
2. Set aside and protect materials suitable for reuse and/or remanufacturing.
3. Separate and fold up metal banding; flatten and place along with other metal scrap for recycling in designated area.

END OF SECTION 092320

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12 inch (300 mm) long length for each trim accessory indicated.
- C. Samples for Initial Selection: For each type of trim accessory indicated.
- D. Samples for Verification: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12 inch (300 mm) long length for each trim accessory indicated.

1.4 QUALITY ASSURANCE

- A. Mockups: Build mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Build mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
 - 2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
 - 3. Simulate finished lighting conditions for review of mockups.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C 1396/C 1396M, Mold and Moisture Resistant.

1. Basis-of-Design Product: Subject to compliance with requirements, provide National Gypsum Company; Gold Bond Brand XP Gypsum Board.
 2. Thickness: 5/8 inch (15.9 mm), unless noted otherwise.
 3. Long Edges: Tapered.
- B. Gypsum Board, Type X: ASTM C 1396/C 1396M, Mold and Moisture Resistant.
1. Basis-of-Design Product: Subject to compliance with requirements, provide National Gypsum Company ; Gold Bond Brand XP Fire Shield Gypsum Board.
 2. Thickness: 5/8 inch (15.9 mm), unless noted otherwise.
 3. Long Edges: Tapered.
- C. Gypsum Ceiling Board, Type C: ASTM C 1396/C 1396M.
1. Basis-of-Design Product: Subject to compliance with requirements, provide National Gypsum Company; High Strength Brand Ceiling Board.
 2. Thickness: 1/2 inch (12.7 mm).
 3. Long Edges: Tapered.
- D. Abuse-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M, Mold and Moisture Resistant.
1. Basis-of-Design Product: Subject to compliance with requirements, provide National Gypsum Company; Hi-Abuse Brand XP Gypsum Board.
 2. Core: 5/8 inch (15.9 mm), Type X, unless noted otherwise.
 3. Long Edges: Tapered.
- 2.4 TRIM ACCESSORIES
- A. Interior Trim: ASTM C 1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.
- B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Fry Reglet Corporation; Reveal Molding and Expansion Joints.

- a. Expansion and Control Reveal Joints: Fry Reglet DB.1 Drywall Expansion Joint, tow piece, 1/2 inch x 1/2 inch: DRM-50-50-2-PC.
 - b. Control Joints at joints to walls and soffits is Fry Reglet DA.9 "W Reveal", 1/2 inch by 1/2 inch : DRWT-50-50.
2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.
4. Approved aluminum trim equal: R. H. Tamlyn & Sons, Ltd. www.tamlyn.com; Tel: (800) 334-1676

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
 2. Exterior Gypsum Soffit Board: Paper.
 3. Glass-Mat Gypsum Sheathing Board: 10 by 10 glass mesh.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Basis of Design: ProForm XP with Dust Tech.
 2. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 3. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 4. Fill Coat: For second coat, use drying-type, all-purpose compound.
 5. Finish Coat: For third coat, use drying-type, all-purpose compound.
 6. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

2.7 TEXTURE FINISHES

- A. Primer: As recommended by textured finish manufacturer.
- B. Acoustical Finish: Refer to Section 098316 Spray Acoustic Plaster. See dwgs for types and locations. Areas (Ceiling Clouds) getting acoustic finish to receive level 3 finish as base for acoustic finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4 to 3/8 inch (6.4 to 9.5 mm) wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4 to 1/2 inch (6.4 to 12.7 mm) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.
- J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

- K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

B. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

- C. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

D. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- (300-mm-) long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws 16 inches (400 mm) o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches (300 mm) o.c.

3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners.
 2. LC-Bead: Use at exposed panel edges.
 3. Curved-Edge Cornerbead: Use at curved openings.
- D. Aluminum Trim: Install in locations indicated on Drawings.

3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 2. Level 2: Panels that are substrate for tile.
 3. Level 3: As base for acoustic finish.

- 4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 099100 "Painting."
 - 5. Level 5: Where vinyl wall signage is proposed, refer to Drawings.
 - a. Primer and its application to surfaces are specified in Section 099100 "Painting."
- E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

3.6 APPLYING TEXTURE FINISHES

- A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

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SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes: Acoustical panels and suspension systems for ceilings, suspended cloud systems.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.
- C. Samples for Initial Selection: For components with factory-applied color finishes.
- D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of 6 inch (150 mm) square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6 inch (150 mm) long Samples of each type, finish, and color.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which suspension systems will be attached.
3. Size and location of initial access modules for acoustical panels.
4. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
5. Perimeter moldings.

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to 2percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical Gypsum Board Ceiling and Cloud, minimum 10 sq. ft area.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned

space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than forty-eight (48) hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: 50 or less.
- B. 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.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
 - 2. Suspension System: Obtain each type from single source from single manufacturer.

- B. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- C. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- D. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.
- E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
 - 1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc. Refer to Schedule for locations.
- B. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type and Form: Type IV, mineral fiber, Form 2.
 - 2. Pattern: E (lightly-textured).
- C. Panel Criteria:
 - 1. Color: White.
 - 2. LR: Not less than 0.90.
 - 3. NRC: Not less than 0.75.
 - 4. CAC: Not less than 35.
 - 5. Edge/Joint Detail: Square.
 - 6. Thickness: 3/4-inch.
 - 7. Modular Size: 24 by 24 inches, and 24 by 48 inches.
- D. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no

mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

- E. Suspension System: Prelude XL 15/16-inch Exposed Tee.

2.4 ACOUSTICAL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc. Refer to Schedule for locations.
- B. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type and Form: Type XII, fiberglass, Form 2.
 - 2. Pattern: E.
- C. Panel Criteria:
 - 1. Color: White.
 - 2. LR: Not less than 0.90.
 - 3. NRC: Not less than 0.90.
 - 4. Edge/Joint Detail: 1/4-inch reveal with 15/16-inch Vector.
 - 5. Thickness: 7/8-inch.
 - 6. Modular Size: 48 by 48 inches.
- D. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
- E. Suspension System: Prelude XL 15/16-inch.

2.5 ACOUSTICAL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc. Refer to Schedule for locations.
- B. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type and Form: Type IV, mineral fiber, Form 2.
 - 2. Pattern: E (lightly-textured).
- C. Panel Criteria:

1. Color: White.
 2. LR: Not less than 0.90.
 3. NRC: Not less than 0.75.
 4. CAC: Not less than 35.
 5. Edge/Joint Detail: Square.
 6. Thickness: 3/4-inch.
 7. Modular Size: 24 by 24 inches.
- D. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
- E. Suspension System: Prelude XL 15/16-inch Exposed Tee.
- F. Sound-Absorbent Fabric Layer: Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flamespread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84.
1. Bond fabric layer to panels in the factory with manufacturer's standard nonflammable adhesive.

2.6 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm) diameter wire.
- D. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- E. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches (610 mm) o.c. on all cross tees.
- F. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including manufacturer's standard gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

2.7 METAL EDGE MOLDINGS AND TRIM

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
 1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.
 2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils (0.04 mm). Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

3. For Cloud Ceilings (Where ceiling does not touch wall.) provide Armstrong 'Axiom' trim, 2 inches high. Color to be selected by Architect.

2.8 ACOUSTICAL SEALANT

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
 - b. United States Gypsum Company; SHEETROCK Acoustical Sealant.
- B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 1. Exposed and Concealed Joints: Non-sag, paintable, non-staining latex sealant.
 2. Concealed Joints: Non-drying, non-hardening, non-skinning, non-staining, gunnable, synthetic-rubber sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 - 1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 8. Do not attach hangers to steel deck tabs.
 - 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
 - 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - 1. Arrange directionally patterned acoustical panels as indicated on reflected ceiling plans.
 - 2. Retain applicable subparagraphs below that coordinate with panel edge details and suspension-system types specified in a schedule.
 - 3. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 - 4. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 - 5. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
 - 6. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 - 7. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.
 - 8. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
 - 9. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

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SECTION 096466 - WOOD FLOORING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wood stage floor refinishing as indicated.

1.2 REFERENCE STANDARDS

- A. MFMA (SPEC) - Guide Specifications for Maple Flooring Systems; current edition.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meetings: Convene a preinstallation meeting one week before starting work of this section; require attendance by affected installers; review preparation and installation procedures and coordination and scheduling necessary for related work.

1.4 SUBMITTALS

- A. Product Data: Provide data for floor finish materials.
- B. Manufacturer's Instructions: Indicate standard and special installation procedures.
- C. Maintenance Data: Include maintenance procedures and recommended maintenance materials.
- D. Installer's qualification statement.

1.5 QUALITY ASSURANCE

- A. Perform work of this section in accordance with MFMA (SPEC).
- B. Installer Qualifications: Company specializing in installing products specified in this section.
 - 1. Minimum three (3) years of documented experience.
 - 2. MFMA accredited and approved by flooring manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and store off the floor in a well-ventilated, weather-tight space.

1.7 FIELD CONDITIONS

- A. Maintain room temperature between 55 degrees F and 75 degrees F and relative humidity between 35 to 50 percent for a period of seven (7) days prior to delivery of materials to installation space, during installation, and after installation.

PART 2 - PRODUCTS

2.1 Finishes

- A. Floor Finishes: Types recommended by flooring manufacturer and complying with MFMA specifications.
 - 1. Sealer: Water based urethane; Bona US, SuperSport DTS.
 - 2. Finish Coats: Water based urethane; high gloss; Bona US SuperSport ONE.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting this work.

3.2 PREPARATION

- A. Vacuum clean substrate.

3.3 INSTALLATION

- A. Refinishing:
 - 1. Mask off adjacent surfaces before beginning sanding.
 - 2. Using course grit sandpaper, remove old finish and level existing imperfections.
 - 3. Transition to finer grits till surface is smooth.
 - 4. Sand flooring to smooth even finish with no evidence of sander marks. Remove dust by vacuum.
 - 5. Apply finishes in accordance with floor finish manufacturer's and MFMA instructions.
 - 6. Apply one sealer coat and three finish coats.
 - 7. Apply first coat, allow to dry, then buff lightly with recommended pad to remove irregularities. Vacuum clean and wipe with damp, lint-free cloth before applying succeeding coats.
 - 8. Apply game lines/markers in accordance with layout indicated on drawings.

9. Apply last coat of finish.

3.4 CLEANING

- A. Clean floor surfaces in accordance with floor finish manufacturer's instructions.

3.5 PROTECTION

- A. Prohibit traffic on finished floor for seventy-two (72) hours after installation.
- B. Place protective coverings over finished floors; do not remove coverings until Date of Substantial Completion.

END OF SECTION 096466

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SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermoset-rubber base.
 - 2. Rubber molding accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches (300 mm) long.
- C. Samples for Initial Selection: For each type of product indicated.
- D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches (300 mm) long.
- E. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

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. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Johnsonite Rubber Base.
- B. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).

1. Style and Location:
 - a. Baseworks Cove.
 - b. Baseworks Toeless.
- C. Thickness: 0.125 inch (3.2 mm).
- D. Height: As indicated on Drawings.
- E. Lengths: Cut lengths 48 inches (1219 mm) long or coils in manufacturer's standard length.
- F. Outside Corners: Preformed.
- G. Inside Corners: Preformed.
- H. Colors: Refer to Material Schedule on drawing AF001.

2.2 RUBBER MOLDING ACCESSORY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Johnsonite.
- B. Description: Rubber nosing for carpet, nosing for resilient floor covering, reducer strip for resilient floor covering, joiner for tile and carpet, transition strips.
- C. Profile and Dimensions: As indicated
- D. Schedule:
 1. Existing Terrazzo →CPT /Johnsonite CTA-XXX-J.
 2. Existing Terrazzo →VCT / Johnsonite RRS-XXX-D.
 3. New Terrazzo → VCT / Johnsonite RRS-XXX-D.
 4. CPT →VCT / Johnsonite SLT-XXX-A.
- E. Colors and Patterns: Refer to Material Schedule on drawing AF001. Match Architect's sample.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

- C. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum horizontal surfaces thoroughly.
 - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from resilient flooring before applying liquid floor polish.
 - 1. Apply two coat(s).
- E. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

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SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Vinyl composition floor tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of resilient floor tile.
 - 1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 2. Show details of special patterns.
- C. Samples: Full-size units of each color, texture, and pattern of floor tile required.
- D. Samples for Verification: Full-size units of each color and pattern of floor tile required.
- E. Product Schedule: For floor tile, use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.6 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. Floor Tile: Furnish one (1) box for every forty (40) boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.
 - a. Size: Minimum 50 sq. ft. (4.6 sq. m) for each type, color, and pattern in locations directed by Architect.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store floor tiles on flat surfaces.

1.9 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.

3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 VINYL COMPOSITION FLOOR TILE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Armstrong World Industries, Inc. Tile Standard: ASTM F 1066, Class 2, through pattern.
- B. Wearing Surface: Smooth.
- C. Thickness: 0.125 inch (3.2 mm).
- D. Name: Excelon Imperial Texture; Excelon Multicolor.
- E. Size, Colors and Patterns: Match existing, and refer to drawing AF001.

2.3 LUXURY VINYL TILE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the following or approved equal:
 1. Refer to drawings.

- B. Tile Standard: Heavy Commercial Luxury Vinyl Tile.
- C. Wearing Surface: Smooth with 20 mil (0.51mm) wear layer.
- D. Thickness: 0.197 inch (5 mm).
- E. Size: As indicated on drawings.
- F. Colors and Patterns: See Material Legends on drawing AF001 for locations, colors, and finishes.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
 - 1. Provide under all flooring going over existing concrete slabs and existing terrazzo slabs, typical.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Resilient flooring over Terrazzo: Strip floor wax in preparation of carpet installation. Remove shine of terrazzo through mechanical means to allow for adhesive adhesion.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- E. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- F. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles square with room axis unless otherwise indicated.

- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles with grain running in one direction in pattern of colors and sizes indicated.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other non-permanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish for VCT: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
 - 1. Apply three (3) coats.

- E. Cover floor tile until Substantial Completion.

END OF SECTION 096519

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SECTION 096613 – PORTLAND CEMENT TERRAZZO FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Cast-in-place terrazzo floor.
- B. Divider strips.

1.2 REFERENCE STANDARDS

- A. ASTM C33/C33M – Standard Specification for Concrete Aggregates; 2013.
- B. ASTM C150/C150M – Standard Specification for Portland Cement; 2015.
- C. NTMA (SPECS) – NTMA Terrazzo Specifications; current edition located at www.ntma.com.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I Normal; white color for topping mix; gray color for underbed; modified to NTMA higher compressive strength requirements; obtained from single source.
- B. Color Pigments for Topping: Non-fading mineral type, alkali-resistant.
- C. Terrazzo Sand: ASTM C33, fine aggregates.
- D. Water: Potable.
- E. Surface Aggregate: Type, color, and size to match existing.

2.2 ACCESSORIES

- A. Divider Strips: 1/8-inch (3mm) thick zinc exposed top strip, zinc coated steel concealed bottom strip, with anchoring features.
- B. Control Joint Strips: 1/8-inch (3mm) nominal width zinc exposed top strips, zinc coated steel concealed bottom strip, 1/8-inch (3mm) wide neoprene filler strip between vertical strips, with anchoring features.

- C. Divider and Control Joint Strip Height: To suit thickness of terrazzo topping with allowance for grinding.
- D. Cleaner: Neutralizing liquid type pH of 7 to 10.

2.3 MIXES

- A. Underbed: One part Portland cement to 4 parts sand by volume. Add water to produce low slump mix.
- B. Floor: Comply with mix requirements of NTMA Plate No. as selected by Architect, white Portland cement, with exposed divider and accessory strips.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.

3.2 PREPARATION

- A. Clean substrate of foreign matter.

3.3 APPLICATION – BONDED TERRAZZO

- A. Place cementitious underbed over wet slurry bond coat, to a nominal thickness of 1-1/4 inches (31 mm).
- B. Place divider strips and control joints at locations indicated and insert in semi-plastic uncured underbed. Install straight and level.
- C. Place terrazzo topping mix over prepared underbed to a nominal thickness of 5/8 inch (16 mm).

3.4 CLEANING

- A. Scrub and clean terrazzo surfaces with cleaner in accordance with NTMA instructions. Let dry.
- B. Seal and polish surfaces in accordance with NTMA instructions.

3.5 PROTECTION

- A. Do not permit construction traffic over finished terrazzo surfaces.

END OF SECTION 096613

SECTION 096816 - SHEET CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Synthetic Turf Rolls.
 - 2. Adhesives.
- B. Related Requirements:
 - 1. Section 024119 "Selective Demolition" for removing existing floor coverings.
 - 2. Division 03 for concrete substrates.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to carpet installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics and durability.
 - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Shop Drawings: For carpet installation, showing the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.

2. Carpet type, color, and dye lot.
 3. Seam locations, types, and methods.
 4. Type of subfloor.
 5. Type of installation.
 6. Pattern type, repeat size, location, direction, and starting point.
 7. Pile direction.
 8. Types, colors, and locations of insets and borders.
 9. Types, colors, and locations of edge, transition, and other accessory strips.
 10. Transition details to other flooring materials.
 11. Type of carpet cushion.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
1. Carpet: 12-inch- (300-mm-) square Sample.
 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.
 3. Carpet Cushion: 6-inch- (150-mm-) square Sample.
 4. Carpet Seam: 6-inch (150-mm) Sample.
 5. Mitered Carpet-Border Seam: 12-inch- (300-mm-) square Sample. Show carpet pattern alignment.
- D. Product Schedule: For carpet and carpet cushion. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet and carpet cushion, for tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet to include in maintenance manuals. Include the following:
 1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 2. Precautions for cleaning materials and methods that could be detrimental to carpet and carpet cushion.

3. Warranty: Warranty documents specified herein.

1.7 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. Carpet: Full-width rolls equal to ten percent (10%) of amount installed for each type indicated, but not less than 5 square yards (4.6 square meters).

1.8 QUALITY ASSURANCE

- A. Certificates: If required, certification of performance characteristics specified in this document shall be provided by the manufacturer.
- B. Installer Qualifications: Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
- C. Pre-installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's instructions, and manufacturer's warranty requirements. Comply with Division 01 Project Management and Coordination (project Meetings) Schedule.
- D. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 1. Build mockups at locations and in sizes as directed by the Architect.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Division 01 Product Requirements Sections.
- B. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays
- C. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

- D. Storage and Protection: Store materials at temperature and humidity conditions recommended by manufacturer and protect from exposure to harmful weather conditions.

1.10 FIELD CONDITIONS

- A. Temperature Requirements: Maintain air temperature in spaces where products will be installed for time period before, during, and after installation as recommended by manufacturer.
- B. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

1.11 WARRANTY

- A. Special Warranty for Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, the following:
 - a. More than ten percent (10%) loss of face fiber, edge raveling, snags, and runs.
 - b. Loss of tuft bind strength.
 - c. Excess static discharge.
 - d. Delamination.
 - 3. Warranty Period: Ten (10) years from date of Substantial Completion.
- B. Special Warranty for Carpet Cushion: Manufacturer agrees to repair or replace components of carpet cushion installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty includes removal and replacement of carpet and accessories required by replacement of carpet cushion.
 - 2. Warranty does not include deterioration or failure of carpet cushion due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 3. Failure includes, but is not limited to, permanent indentation or compression.
 - 4. Warranty Period: Ten (10) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYNTHETIC TURF

- A. Basis of Design: Refer to AF drawings.
 - 1. Approved equal.
- B. Color: Refer to AF drawings.
- C. Pattern: Refer to AF drawings.
- D. Primary Backing: Refer to AF drawings.
- E. Roll Width: Refer to AF drawings.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, non-staining two-component urethane, moisture-cured type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet and carpet cushion manufacturer.
- C. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance.
- B. Examine carpet for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m) and perform no fewer than two (2) tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 95 percent relative humidity level measurement.
 - c. Perform additional moisture tests recommended in writing by adhesive, carpet cushion, and carpet manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet manufacturer's written installation instructions for preparing substrates.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive, carpet, and carpet cushion manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

- A. Comply with the Carpet and Rug Institute's CRI 104 and carpet and carpet cushion manufacturer's written installation instructions for the following:
 1. Direct-glue-down installation.
 2. Carpet with attached-cushion installation.

- B. Comply with carpet manufacturer's written instructions and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.
 - 1. Stretch-in Carpet Installation: Install carpet cushion seams at 90-degree angle with carpet seams.
- C. Install as indicated on Drawings.
- D. Install borders with mitered corner seams.
- E. Do not bridge building expansion joints with carpet.
- F. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
- G. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- H. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet as marked on subfloor. Use non-permanent, non-staining marking device.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
 - 2. Remove yarns that protrude from carpet surface.
 - 3. Vacuum carpet using commercial machine with face-beater element.
- B. Protect installed carpet to comply with the Carpet and Rug Institute's CRI 104.
- C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods recommended in writing by carpet manufacturer and carpet cushion manufacturer.

END OF SECTION 096816

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SECTION 099100 – PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.
 - 1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item, or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.
 - 1. Painting includes field painting of exposed structural columns and related elements; exposed and bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
 - 1. Prefinished items include the following factory-finished components:
 - a. Architectural woodwork.
 - b. Visual display surfaces.
 - c. Toilet enclosures.
 - d. Metal lockers.
 - e. Aluminum window and doorframes.
 - f. Coiling overhead doors.
 - g. Impact resistant wall protection.
 - h. Operable panel partitions.
 - i. Storage shelving.
 - j. Finished mechanical and electrical equipment.
 - k. HVAC inlets and outlets.
 - l. Light fixtures.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
 - a. Foundation spaces.
 - b. Furred areas.
 - c. Ceiling plenums.
 - d. Utility tunnels.
 - e. Pipe spaces.
 - f. Duct shafts.
 - g. Elevator shafts.
3. Finished metal surfaces include the following:
 - a. Anodized aluminum.
 - b. Stainless steel.
 - c. Chromium plate.
 - d. Copper and copper alloys.
 - e. Bronze and brass.
4. Operating parts include moving parts of operating equipment and the following:
 - a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.
5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections include the following:

1. Division 05 Section "Structural Steel" for shop priming structural steel.
2. Division 05 Section "Metal Fabrications" for shop priming ferrous metal.
3. Division 05 Section "Pipe and Tube Railings" for shop priming railings.
4. Division 06 Section "Interior Architectural Woodwork" for shop priming interior architectural woodwork.
5. Division 08 Section "Hollow Metal Doors and Frames" for factory priming steel doors and frames.
6. Division 08 Section "Flush Wood Doors" for factory finishes to flush wood doors.

1.3 DEFINITIONS AND REFERENCES

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
3. Semi-gloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.

- B. PDCA (Painting and Decorating Contractors of America) – Painting - Architectural Manual.
- C. SSPC (Steel Structures Painting Council) – Steel Structures Painting Manual.

1.4 SUBMITTALS

- A. Product Data: For each paint system indicated. Include block fillers and primers.
 - 1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 - 2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.
- B. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
 - 1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
 - 2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
 - 3. Submit two (2) samples on the following substrates for Architect's review of color and texture only:
 - a. Ferrous Metal: 4-inch square samples of flat metal and 8-inch-long samples of solid metal for each color and finish.
 - b. Gypsum board and plaster: 12-inch square samples for each color and finish.
- C. Qualification Data: For Applicator.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.
- C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample for each type of coating and each new and existing substrate required. Comply with procedures specified in PDCA P5. Duplicate finish of approved sample Submittals.

1. Architect will select one room or surface to represent surfaces and conditions for application of each type of coating and substrate.
 - a. Wall Surfaces: Provide samples on at least 100 square feet.
 - b. Small Areas and Items: Architect will designate items or areas required.
2. Apply benchmark samples, according to requirements for the completed Work, after permanent lighting and other environmental services have been activated. Provide required sheen, color, and texture on each surface.
 - a. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.
 - b. Refinish benchmark areas according to finish schedule prior to completion of Work following Architects direction and approval.
3. Final approval of finishes and colors will be from benchmark samples.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
 1. Product name or title of material.
 2. Product description (generic classification or binder type).
 3. Manufacturer's stock number and date of manufacture.
 4. Contents by volume, for pigment and vehicle constituents.
 5. Thinning instructions.
 6. Application instructions.
 7. Color name and number.
 8. VOC content.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F and a maximum of 90 deg F. Maintain storage containers in a clean condition, free of foreign materials and residue.
 1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.7 PROJECT CONDITIONS

- A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F.
- B. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F.

- C. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.8 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied and, in the quantities, described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
 - 1. Quantity: Furnish Owner with extra paint materials in quantities indicated below:
 - a. Two (2) full unopened gallons of each color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.
- B. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Benjamin Moore & Co. (Benjamin Moore).
 - 2. Sherwin-Williams.
 - 3. PPG Industries, Inc.

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
- C. Colors: Colors, textures, and other physical characteristics of the final finish may be referenced by specification of a single manufacturer's numbering system. Match referenced materials.

2.3 CONCRETE UNIT MASONRY BLOCK FILLERS

- A. Concrete Unit Masonry Block Filler: Factory-formulated high-performance latex block fillers.
 1. Benjamin Moore; Moorcraft Super Craft Latex Block Filler No. 285: Applied at a dry film thickness of not less than 8.1 mils.
 2. Sherwin-Williams; PrepRite Interior/Exterior Block Filler B25W25: Applied at a dry film thickness of not less than 8.0 mils.

2.4 EXTERIOR PRIMERS

- A. Exterior Ferrous-Metal Primer: Factory-formulated rust-inhibitive metal primer for exterior application.
 1. Benjamin Moore; Moore's IMC Alkyd Metal Primer No. Z06: Applied at a dry film thickness of not less than 2.0 mils.
 2. Sherwin-Williams; Kem Bond HS Universal Metal Primer B50 Series: Applied at a dry film thickness of 2.0-2.5 mils.
- B. Exterior Galvanized Metal Primer: Factory-formulated galvanized metal primer for exterior application.
 1. Benjamin Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils.
 2. Sherwin-Williams; Pro-Cryl Universal Water Based Primer B66-310 Series: Apply at a dry film thickness of 2.0-4.0 mils.

2.5 INTERIOR PRIMERS

- A. Interior Concrete and Masonry Primer: Factory-formulated alkali-resistant acrylic-latex interior primer for interior application.

1. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
 2. Sherwin-Williams; PrepRite Masonry Primer B28W300: Applied at a dry film thickness of not less than 3.0 mils.
- B. Interior Gypsum Board Primer: Factory-formulated latex-based primer for interior application.
1. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
 2. Sherwin-Williams; PrepRite 200 Latex Wall Primer B28W200 Series: Applied at a dry film thickness of not less than 1.6 mils.
- C. Interior Plaster Primer: Factory-formulated latex-based primer for interior application.
1. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
 2. Sherwin-Williams; PrepRite Masonry Primer B28W300 Series: Applied at a dry film thickness of not less than 3 mils.
- D. Interior Wood Primer for Acrylic-Enamel and Semigloss Alkyd-Enamel Finishes: Factory-formulated alkyd- or acrylic-latex-based interior wood primer.
1. Benjamin Moore; Fresh Start Alkyd Enamel Underbody and Primer Sealer No. 217: Applied at a dry film thickness of not less than 1.5 mils.
 2. Sherwin-Williams; PrepRite Classic Interior Primer B28W101 Series: Applied at a dry film thickness of not less than 1.6 mils.
- E. Interior Ferrous-Metal Primer: Factory-formulated quick-drying rust-inhibitive alkyd-based metal primer.
1. Benjamin Moore; Moore's IMC Alkyd Metal Primer No. Z06: Applied at a dry film thickness of not less than 2.0 mils.
 2. Sherwin-Williams; Kem Bond HS Universal Metal Primer B50 Series: Applied at a dry film thickness of 3.0-8.0 mils.
- F. Interior Zinc-Coated Metal Primer: Factory-formulated galvanized metal primer.
1. Benjamin Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils.
 2. Sherwin-Williams; Pro-Cryl Universal Water Based Primer B66-310 Series: Applied at a dry film thickness of 5.0-10.0 mils.
- G. Interior Semigloss Epoxy Primer/Sealer: Factory-formulated semigloss epoxy primer/sealer for interior application

1. Sherwin-Williams; ArmorSeal 33 Epoxy Primer/Sealer: Applied at a dry film thickness of not less than 8.0 mils.

2.6 EXTERIOR FINISH COATS

- A. Exterior Semi-gloss Acrylic Enamel: Factory-formulated semi-gloss waterborne acrylic-latex enamel for exterior application.
 1. Benjamin Moore; Moorcraft Super Spec Latex House & Trim Paint No. 170: Applied at a dry film thickness of not less than 1.1 mils.
 2. Sherwin-Williams; A-100 Latex Gloss A8 Series: Applied at a dry film thickness of not less than 1.3 mils.
- B. Exterior Low-Luster Acrylic Paint: Factory-formulated low-sheen (eggshell) acrylic-latex paint for exterior application.
 1. Benjamin Moore; Moorcraft Super Spec Low Lustre Latex House Paint No. N185: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm).
 2. Sherwin-Williams; A-100 Exterior Latex Satin House & Trim Paint A82 Series: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).

2.7 INTERIOR FINISH COATS

- A. Interior Flat Acrylic Paint: Factory-formulated flat acrylic-emulsion latex paint for interior application.
 1. Benjamin Moore; Moorcraft Super Spec Latex Flat No. 275: Applied at a dry film thickness of not less than 1.2 mils.
 2. Sherwin-Williams; ProMar 200 Interior Latex Flat Wall Paint B30W200 Series: Applied at a dry film thickness of not less than 1.4 mils.
- B. Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel.
 1. Benjamin Moore; Moorcraft Super Spec Latex Eggshell Enamel No. C274: Applied at a dry film thickness of not less than 1.3 mils.
 2. Sherwin-Williams; ProMar 200 Interior Latex Egg-Shell Enamel B20W200 Series: Applied at a dry film thickness of not less than 1.6 mils.
- C. Interior Semi-gloss Acrylic Enamel: Factory-formulated Semi-gloss acrylic-latex enamel for interior application.
 1. Benjamin Moore; Moorcraft Super Spec Latex Semi-Gloss Enamel No. 276: Applied at a dry film thickness of not less than 1.2 mils.
 2. Sherwin-Williams; ProMar 200 Interior Latex Semi-Gloss Enamel B31W200 Series: Applied at a dry film thickness of not less than 1.3 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application. Comply with procedures specified in PDCA P4.
 - 1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 - 2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 - 1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface- applied protection before surface preparation and painting.
 - 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.
 - 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
 - 1. Provide barrier coats over incompatible primers or remove and reprime.
 - 2. Plaster Surfaces: Fill hairline cracks, small holes, and other imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.

3. Gypsum Board Surfaces: Fill minor defects with filler compound. Make smooth and flush with adjacent surfaces. Spot prime defects after repair.
4. Cementitious Materials: Prepare concrete, concrete unit masonry, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
 - a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
 - b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
 - c. Clean concrete floors to be painted with a five percent (5%) solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry and vacuum before painting.
5. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
 - a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
 - b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood, including cabinets, counters, cases, and paneling.
 - c. If transparent finish is required, backprime with spar varnish.
 - d. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on back side.
 - e. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
6. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.
 - a. Blast steel surfaces clean as recommended by paint system manufacturer and according to SSPC-SP 6/NACE No. 3.
 - b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 - c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.

7. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
- D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 3. Use only thinners approved by paint manufacturer and only within recommended limits.
- E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the finish coat but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
 1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 3. Provide finish coats that are compatible with primers used.
 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convactor covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 6. Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers or grilles.
 7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
 9. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
 10. Sand lightly between each succeeding enamel or varnish coat.

- B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 - 2. Omit primer over metal surfaces that have been shop primed and touchup painted.
 - 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 - 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
- C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
 - 1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 - 2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 - 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
- D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
- E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.
- F. Mechanical items to be painted include, but are not limited to, the following:
 - 1. Uninsulated metal piping.
 - 2. Uninsulated plastic piping.
 - 3. Uninsulated ductwork.
 - 4. Pipe hangers and supports.
 - 5. Tanks that do not have factory-applied final finishes.

6. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
 7. Duct, equipment, and pipe insulation having "all-service jacket" or other paintable jacket material.
 8. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
- G. Electrical items to be painted include, but are not limited to, the following:
1. Exposed conduits and junction boxes.
- H. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.
- I. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- J. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- K. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
1. Provide satin finish for final coats.
- L. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.
- M. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.
- 3.4 FIELD QUALITY CONTROL
- A. Owner reserves the right to invoke the following test procedure at any time and as often as Owner deems necessary during the period when paint is being applied:

1. Owner will engage a qualified independent testing agency to sample paint material being used. Samples of material delivered to Project will be taken, identified, sealed, and certified in the presence of Contractor.
2. Owner may direct Contractor to stop painting if test results show material being used does not comply with specified requirements. Contractor shall remove noncomplying paint from Project site, pay for testing, and repaint surfaces previously coated with the noncomplying paint. If necessary, Contractor may be required to remove noncomplying paint from previously painted surfaces if, on repainting with specified paint, the two coatings are incompatible.

3.5 CLEANING

- A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.
 1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.6 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing, or replacing, and repainting, as approved by Architect.
- B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.
 1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.7 EXTERIOR PAINT SCHEDULE

- A. Ferrous Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items.
 1. Semi-gloss Acrylic-Enamel Finish: Two (2) finish coats over a rust-inhibitive primer.
 - a. Primer: Exterior ferrous-metal primer.
 - b. Finish Coats: Exterior semi-gloss acrylic enamel.
- B. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated metal surfaces:

1. Semi-gloss Acrylic-Enamel Finish: Two (2) finish coats over a galvanized metal primer.
 - a. Primer: Exterior galvanized metal primer.
 - b. Finish Coats: Exterior semi-gloss acrylic enamel.
- C. Exterior Gypsum Soffit Board: Provide the following finish system over exterior gypsum soffit board:
 1. Low-Luster Acrylic Finish: Two (2) finish coats over a primer.
 - a. Primer: Exterior gypsum soffit board primer.
 - b. Finish Coats: Exterior low-luster acrylic paint.

3.8 INTERIOR PAINT SCHEDULE

- A. Concrete and Masonry (Other Than Concrete Unit Masonry): Provide the following paint systems over interior concrete and brick masonry substrates:
 1. Semi-gloss Acrylic-Enamel Finish: Two (2) finish coats over a primer.
 - a. Primer: Interior concrete and masonry primer.
 - b. Finish Coats: Interior semi-gloss acrylic enamel.
- B. Concrete Unit Masonry: Provide the following finish systems over interior concrete masonry:
 1. Low-Luster Acrylic-Enamel Finish: Two (2) finish coats over a block filler.
 - a. Block Filler: Concrete unit masonry block filler.
 - b. Finish Coats: Interior low-luster acrylic enamel.
 2. Semi-gloss Acrylic-Enamel Finish: Two (2) finish coats over a block filler.
 - a. Block Filler: Concrete unit masonry block filler.
 - b. Finish Coats: Interior semi-gloss acrylic enamel.
- C. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:
 1. Flat Acrylic Finish: Two (2) finish coats over a primer.
 - a. Primer: Interior gypsum board primer.
 - b. Finish Coats: Interior flat acrylic paint.
 2. Low-Luster Acrylic-Enamel Finish: Two (2) finish coats over a primer.
 - a. Primer: Interior gypsum board primer.
 - b. Finish Coats: Interior low-luster acrylic enamel.
 3. Semi-gloss Acrylic-Enamel Finish: Two (2) finish coats over a primer.
 - a. Primer: Interior gypsum board primer.
 - b. Finish Coats: Interior semi-gloss acrylic enamel.
- D. Plaster: Provide the following finish systems over new interior plaster surfaces:

1. Low-Luster Acrylic-Enamel Finish: Two (2) finish coats over a primer.
 - a. Primer: Interior plaster primer.
 - b. Finish Coats: Interior low-luster acrylic enamel.
 2. Semi-gloss Acrylic-Enamel Finish: Two (2) finish coats over a primer.
 - a. Primer: Interior plaster primer.
 - b. Finish Coats: Interior semi-gloss acrylic enamel.
- E. Wood and Hardboard: Provide the following paint finish systems over new interior wood surfaces:
1. Semi-gloss Acrylic-Enamel Finish: Two (2) finish coats over a wood undercoater.
 - a. Primer: Interior wood primer for acrylic-enamel and semi-gloss alkyd-enamel finishes.
 - b. Finish Coats: Interior semi-gloss acrylic enamel.
- F. Ferrous Metal: Provide the following finish systems over ferrous metal:
1. Semi-gloss Acrylic-Enamel Finish: Two (2) finish coats over a primer.
 - a. Primer: Interior ferrous-metal primer.
 - b. Finish Coats: Interior semi-gloss acrylic enamel.
- G. Zinc-Coated Metal: Provide the following finish systems over interior zinc-coated metal surfaces:
1. Semi-gloss Acrylic-Enamel Finish: Two (2) finish coats over a primer.
 - a. Primer: Interior zinc-coated metal primer.
 - b. Finish Coats: Interior semi-gloss acrylic enamel.

END OF SECTION 099100

SECTION 118129 - FACILITY FALL PROTECTION

PART 1 - GENERAL

1.1 Section Includes

- A. Ladder safety systems.

1.2 Related Requirements

- A. Section 055133 - Metal Ladders.

1.3 Reference Standards

- A. 29 CFR 1910.23 - Ladders; Current Edition.
- B. 29 CFR 1910.29 - Fall Protection Systems and Falling Object Protection - Criteria and Practices; Current Edition.
- C. 29 CFR 1910.140 - Personal fall protection systems; Current Edition.
- D. 29 CFR 1926.1053 - Ladders; Current Edition.
- E. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements; 2008 (Reaffirmed 2018).
- F. ANSI/ASSP Z359.16 - Safety Requirements for Climbing Ladder Fall Arrest Systems; 2016.

1.4 Submittals

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's data sheets on each ladder safety system product to be used, including installation instructions.
- C. Product Data: Material, equipment, and fixture lists. Manufacturer's catalog data indicating the sizes, descriptions, capacities, test certifications, and other descriptive data showing in sufficient detail that product complies with contract requirements. Equipment and performance data including but not limited to lifeline anchors, safety tieback anchors, and lifeline cable.

- D. Shop Drawings: Installation details: plan showing locations and types of anchorage points for personal fall protection systems and building maintenance equipment.
- E. Certificate: Certify that products of this section meet or exceed specified requirements.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.
- H. Operation Data: Provide operating instructions and identify unit limitations.
- I. Maintenance Data: Include parts list and maintenance requirements for equipment.

1.5 Quality Assurance

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

1.6 Warranty

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 Ladder Safety Systems

- A. Climbing Ladder Fall Arrest System (CLAFS):
 - 1. Manufacturers:
 - a. 3M Personal Safety Division: www.3M.com/FallProtection/#sle.
 - b. EDGE Fall Protection: www.edgefallprotection.com/#sle.
 - c. MSA Safety Incorporated: www.msasafety.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 2. Description: Climbing ladder fall arrest system allows worker to climb up and down using both hands; does not require employee continuously, hold, push, or pull any part of system while climbing.

3. Comply with 29 CFR 1910.29, 29 CFR 1926.1053, Section 7 of ANSI A14.3 and ANSI/ASSP Z359.16.
 4. Install on new fixed ladders over 24 feet in height.
 5. Anchorage: Fixed ladder meeting requirements of 29 CFR 1910.23.
- B. Ladder Safety System:
1. Manufacturers:
 - a. EDGE Fall Protection: www.edgefallprotection.com/#sle.
 - b. Guardian Fall Protection: www.guardianfall.com/#sle.
 - c. Honeywell International, Inc: www.honeywell.com/#sle.
 - d. Sellstrom Manufacturing Company: www.fallprotection.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 2. Description: Ladder safety system allows the worker to climb up and down using both hands; does not require the employee continuously, hold, push, or pull any part of the system while climbing.
 3. Comply with 29 CFR 1910.29, 29 CFR 1926.1053, and Section 7 of ANSI A14.3.
 4. Install on new fixed ladders over 24 feet in height.
 5. Anchorage: Fixed ladder meeting requirements of 29 CFR 1910.23.
- C. Personal Fall Arrest System Components; 29 CFR 1910.140:

PART 3 - EXECUTION

3.1 Examination

- A. Examine area for compliance with requirements for installation tolerances and other conditions related to this work.
- B. Confirm that the ladder structure to which the ladder safety system is installed can withstand the loads applied by the system in the event of a fall.

3.2 Preparation

- A. Coordinate location of fall protection equipment indicated to be attached to structural substrate or surface of roofing system and provide anchoring devices with templates, diagrams, and installation instructions.

3.3 Installation

- A. Install anchorage and fasteners in accordance with shop drawings and manufacturer's recommendations to obtain allowable working loads published in product literature and in accordance with this specification.

END OF SECTION 118129

SECTION 126100 – FIXED AUDIENCE SEATING (FOR REFERENCE)

PART 1 – GENERAL

1.1 SUMMARY

- A. Owner to furnish and install approximately 900 fixed padded and upholstered chairs as specified, floor-mounted, with self-lifting seat that rises to a uniform 3/4-safety fold position.

1.5 COORDINATION

- A. General Contractor shall prep the existing concrete slabs, including full removal of all existing seats, fasteners, and anchor bolts.
- B. General Contractor shall coordinate layout and installation of electrical wiring and devices with electrical contractor to ensure that floor junction boxes for electrical devices and aisle lighting are accurately located for final connection to the building's power supply by the electrical contractor.

PART 2 – PRODUCTS (by Owner via State Contract)

PART 3 – EXECUTION (by Owner via State Contract)

END OF SECTION 126100

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SECTION 190500 – THEATRICAL LIGHTING AND CONTROLS BASIC REQUIREMENTS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Division 01 Specification Sections, apply to this Section.
- B. It is the responsibility of the Electrical Contractor to fully coordinate the integration and installation of all equipment and furnishings as described in this section with a Theatrical Systems Integrator (TSI) to ensure proper operation of the system.
- C. One company shall be responsible for the installation of all aspects of the theatrical rigging equipment with a Theatrical Systems Integrator (TSI) to ensure proper operation of the system. Work under this section shall include furnishing all labor, materials, tools, transportation services, supervision, etc., necessary to complete installation of the stage rigging equipment as well as any other items as herein listed, all as described in these specifications, as illustrated on the accompanying drawings; or as directed by the Owner's Representative.

1.2 SYSTEM DESCRIPTION

- A. The system shall be designed for the control of architectural lighting, theatrical lighting, and audiovisual equipment. The system shall consist of factory pre-wired dimming and processing rack enclosures containing dimmers, relays, power supplies, breakers, terminals and/or control electronics.
- B. The system shall be primarily controlled via unified touch panel controls as specified.
- C. System shall work in conjunction with specified low-voltage control stations and specified control consoles.
- D. The system shall include theatrical lighting fixtures and audiovisual equipment and accessories as specified herein.

- E. The system is designed to meet specific operational requirements for the Owner and their representatives. Deviations from performance will not be accepted.

1.3 WORK INCLUDED

- A. The Electrical Contractor, as part of the work of this section, shall provide, install, and test a complete unified audiovisual and lighting control system as specified herein for areas indicated on the drawings and circuit schedules.
- B. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and proper operation of the unified audiovisual and lighting control system.
- C. It is the responsibility of the Electrical Contractor to obtain the services of a qualified Theatrical Systems Integrator to provide the system described herein.
- D. Attach all load wires in relay panel per load schedules.
- E. Bring branch fed power feed into new relay enclosure and terminate per manufacturers' specifications.
- F. On-site training of operations personnel on the use and maintenance of the systems and equipment provided as part of this specification.
- G. New dimming and control equipment shall be appropriately sized to accommodate all existing loads, as well as leave room for future expansion.

1.4 QUALITY ASSURANCE

- A. All equipment, where applicable standards have been established, shall be built to the standards of Underwriters Laboratories, Inc., the National Electric Code and the United States Institute for Theater Technology. Permanently installed power distribution equipment such as dimmer racks and distribution shall be UL and C-UL Listed, and/or CE marked (where applicable) and bear the appropriate labels. Portable equipment such as consoles and fixtures shall be UL and C-UL Listed, ETL Listed and/or CE marked (where applicable) and bear the appropriate labels.

1.5 SCOPE

- A. Due to the complexity of this system and the specific combination of equipment and services required for professional installation, equipment in this specification shall be purchased from an approved Theater Systems Integrator (TSI) hired by the general contractor.
- B. This is a single source specification, one Theatrical Systems Integrator (TSI) shall be responsible for supplying the unified audiovisual and lighting control equipment, audiovisual equipment, stage lighting fixtures, dead hung rigging, Project Management, stage lighting fixture hanging and focusing, audiovisual tuning and alignment, and programming of the system prior to Owner's possession.
- C. The Theatrical Systems Integrator shall be a sub-contractor to and fully coordinated by the Division 26 Electrical Contractor.
- D. The Theatrical Systems Integrator shall be responsible for supervising the installation of the unified audiovisual and lighting control equipment. Specifically; provide a dedicated Project Manager, to schedule shipments of equipment, coordinate deliveries, answer system inquiries, and generally oversee the installation of the unified audiovisual control equipment, audiovisual equipment, theatrical rigging, and circuit distribution.
- E. It is the responsibility of the Theater Systems Integrator, in conjunction with the manufacturers, to provide the following:
 - 1. Verification of dimensions and conditions in contract documents prior to equipment installation.
 - 2. Coordination of scheduling and delivery of materials to job site.
 - 3. Testing and inspection of completed installation.
 - 4. Electronic PDF sets of submittals and shop drawings for approval by Architect prior to installation.
 - 5. Turn-on/Energization of unified audiovisual and lighting control system, initial programming of system and components.
 - 6. System training for owner representatives
 - 7. Coordination with associated trades in the field.

1.6 Contractor Responsibility Matrix

Item	GC		EC		TSI	
	Furnish	Install	Furnish	Install	Furnish	Install
<u>Control & Power</u>						
Power Feeds			X	X		
Power Disconnects			X	X		
Dimming Enclosures/System Controlled Relay Panels				X	X	
Control Rack Internal Equipment					X	X
Control Rack				X	X	
Interconnections From Control Rack to Peripheral Components			X	X		
Line Voltage Wire			X	X		
Line Voltage Wire Terminals			X	X		
Low Voltage Wire			X		X	
Low Voltage Terminations			X	X		
Conduit			X	X		
<u>Power and Data Distribution</u>						
Power Outlet Boxes			x	x		
Branch Wiring from Power Control Enclosures to Outlet Boxes			x	x		
Data Outlet Boxes				x	x	
Low Voltage Wiring To Outputs Inside Outlet Boxes & Inputs For Consoles			x	x		
Low Voltage Wiring from Outlet Boxes to				X	X	

Consoles and other Peripherals						
Consoles Plug-In Stations				X	X	
Containment			X	X		
<u>Peripheral Components</u>						
Lighting Fixtures and Accessories				X	X	
Lighting Control Console and Accessories					X	X
Speakers and Accessories				X	X	
Audio Console and Accessories					X	X
Projectors, Projector Screens, and Accessories				X	X	
Cameras and Accessories				X	X	
Video Console and Accessories					X	X
Faceplate/Wallplates				X	X	
<u>Miscellaneous</u>						
Fire Stop			X	X		
Cutting/Patching/Paint ing	X	X				
Protection of Existing Floors/Walls/Surfaces	X	X				
Disposal/Cleanup/Carti ng	X	X				
System Commissioning					X	
System Training					X	
Temporary Work Lights and Power			X	X		
Ventilation	X	X				

PART 2 - THEATRICAL SYSTEMS INTEGRATOR (TSI)

2.1 General

- A. The provider of the system herein described shall be acknowledged in business as a Theatrical Systems Integration Company, hereafter referred to as TSI. This company shall employ full-time Systems Integrators and Project Managers with experience in completing work of similar or greater size and scope. The role of the TSI in this project shall be to provide all equipment listed in this section to the Electrical Contractor for installation. The TSI shall furnish a complete working system to the Electrical Contractor, meeting the intent of this specification. The TSI shall coordinate delivery schedules and installation of equipment with the Electrical Contractor. Additionally, the TSI shall be responsible for all documentation for equipment in this section, system record drawings, final testing of the system and training of the Owner's personnel as required by this specification.

2.2 Description

- A. The TSI shall have experience in the operation and installation of similar equipment associated with the construction and/or renovation of facilities similar in scope to this project.
- B. The TSI shall be an authorized service provider of the specified unified audiovisual and lighting system.
- C. The TSI shall be an authorized dealer for an adequate number of manufacturers of system products necessary to provide a complete working system meeting the intent of this specification. System products shall include, but are not limited to, the following:
 - 1. Unified Audiovisual and Lighting Control System
 - 2. Lighting Fixtures
 - 3. Power Distribution Equipment
 - 4. Speakers
 - 5. Microphones
 - 6. Projectors and Projection Screens
 - 7. Audiovisual Accessories

8. Stage Accessories
 9. Static Electric Onstage Line Sets
- D. The TSI shall be located within fifty (50) miles of the job site.
- E. The TSI shall offer a Maintenance and Service Contract.
- F. The TSI shall have on staff at least two (2) full-time manufacturer-certified field service technicians and have technical support and assistance accessible twenty-four (24) hours a day, seven (7) days a week.
- G. For a 2-year warranty period, the TSI shall be responsible as the Owner's sole contact for the remedy, repair, or replacement of system deficiencies.

2.3 Project Management

- A. The Systems Integration Company shall designate a dedicated Project Manager. The TSI's Project Manager shall be the main contact between the Systems Integrator, Manufacturers, Architects, Engineers and Contractors from contract award until final sign off.
- B. The TSI's Project Manager shall attend a Kick-Off Meeting at the project site or a place to be designated. The objectives of the Kick-Off Meeting are:
1. Introduce the Project Team Members.
 2. Review the Project Schedule.
 3. Review the Scope of Work and any additional materials and documents not in the Scope of Work.

2.4 Approved Theatrical Systems Integration Companies shall be the following:

- A. PureTek Group
315 Wootton Street
Boonton, NJ 07005
Ph: (973) 915-3133

2.5 Warranty

- A. All systems, including all parts and labor, shall be under full warranty for a period of not less than two (2) years from the date of written final acceptance. In the event that any of the equipment should fail to produce capacities or meet design characteristics as specified, it shall be replaced with equipment that will meet requirements without additional cost. After occupancy, any necessary work performed shall be done at the convenience of the Owner's operational schedule, including overtime, if required.

PART 2 – PRODUCTS

1. Unified Rigging Audio Visual Lighting Controls

A. Acceptable Systems

1.unRAVL

B. Control Rack – General

1. Provide multi-microprocessor based, solid state rigging-audio-video-lighting processors (RAVL-P) that functions independently and in conjunction with lighting consoles, audio consoles, and video consoles.
2. RAVL-P shall be capable of controlling dimming racks, relay panels, addressable LED system (where applicable), automated lighting fixtures, automated hoists rigging systems, audio consoles, projectors, motorized projection screens, digital displays, speakers, and other devices via appropriate protocols (DMX, RDM, sACN, Dante, dry contact).
3. Digital network control system capable of remote access by manufacturer with the following features:
 - a. System diagnostics including detection of fault condition in hardware or connected devices.
 - b. Access to all connected devices for complete programming including scheduling of time-of-day events and device parameters necessary to meet required sequence of operations.
 - c. Browser-based interface to verify system functionality.
 - d. On-demand access to manufacturer technical support for remote troubleshooting, diagnostics, configuration, and programming.
4. Programming of system integration backbone to be done via javascript and shall not require proprietary software packages not available for download and installation by the system installer and end customer.
5. Programming of system and system updates to be performed by certified integrator

6.RAVL-P Functions:

- a. One-Touch control for system presets (rigging, audio, video, lighting) via Presets Menu.
- b. Full control over audio input/output active selection and levels of input/output.
- c. Control over video signal distribution. Signals for different video transmission devices can be routed to any or all of the available video outputs as indicated on the touch screen. Video signals in to be shown in thumbnails on the video signal distribution control page.
- d. Full granular control of lighting levels, color (where applicable), and focus (where applicable), including entry station and touchscreen presets. Creation of cues and cues activation available through touchscreen interface.
- e. Control over power sequencing of the audio and visual projection systems. Power control includes power cycling of the following items:
 - 1) Rack power in the following proper sequence to not damage equipment:
 - i. Power speaker amplifiers (8 amplifiers sequenced)
 - ii. Power microphone systems
 - iii. Power audio mixer systems
 - 2) Video projector
 - 3) Theatrical lighting electrical pipes system power
- f. Priority setting for lighting control
 - 1) Priority setting to be fully customizable
 - 2) Default setting to have touchscreen and entry stations at a lower priority than console.
 - 3) Console to have full and exclusive control of lighting system when connected and powered on.
- g. QR Code provided for external device to connect and control system. Device must be on same network as control system.

7.Audio Powered Output Properties

- a. Control Rack to have eight (8) audio power amplifier to power external passive speakers:

- 1) Amp A: 8-channel power amplifier with integrated DSP, 4 x 800 Watts RMS @ 4-Ohms Output

b. Features

- 1) Professional power amplifier for high and low-impedance loads
- 2) Digital signal processor (DSP) with FIR-filters (FIR-Drive)
- 3) USB 2.0 connection for PC remote control and supervision
- 4) Four (4) balanced analogue audio inputs on 3.81 mm Euroblock connectors (Input 1 and 2 can be switched to AES/EBU digital input and output)
- 5) Four (4) power outputs in 5.08mm Euroblock format
- 6) Two (2) Ethernet ports capable of supporting transmission of four (4) Dante® digital inputs and four (4) Dante® outputs
- 7) Four (4) configurable GPIO (General Purpose Input/Output) ports
- 8) Standby control input

c. Digital Signal Processing

- 1) AD: 24 Bit @48kHz
- 2) DA: 24 Bit @48kHz
- 3) Limiters: Compressor on processing channels, Peak limiter on output channel (also used in dBTechnologies preset)

d. Amplifier

- 1) Protection package: Thermal protection, output short circuit, RMS output current protection, high frequency protection, power limiter, clip limiter
- 2) Audio and logic connectors:
 - i. Input:
4 x Analogue (Euroblock) or 2 x Analogue + AES/EBU (user configurable)
 - ii. Output:
4 x amplified outputs, AES/EBU (configurable)
4 x Dante® channels
 - iii. Remote connectivity:
 1. 2x Ethernet RJ45
 2. 1x USB-B

3. 3.81mm Euroblock format, which can be used as GPI, GPO, analogue and as a dedicated standby input
- e. Technical specifications:
 - 1) Type: Switching mode, Class D Amplifier
 - 2) Impedance: Minimum 4 Ω
 - 3) Frequency Response (8-Ohm): 20 Hz – 20 kHz (± 0.5 dB)
 - 4) Amplifier gain: 31 dB
 - 5) Signal/noise ratio: > 103 dB(A)
 - 6) Input sensitivity: +4 dBU
 - 7) Maximum input level: +18 dBU
 - 8) Crosstalk: 100 dB
 - 9) Input impedance: 20 kOhm
8. Communication Protocols:
 - a. ANSI E1.11-2004 (USITT DMX-512/1990)
 - b. ANSI/PLASA E1.20 (RDM)
 - c. ANSI/PLASA E1.31 (sACN)
 - d. ANSI/PLASA E1.17 (ACN)
 - e. IEEE 802.3 Ethernet
 - f. IEEE 802.3af Power-over-Ethernet (PoE)
 - g. IEEE 802.1AB Link Layer Discovery Protocol (LLDP)
 - h. IEEE 802.1Q VLAN Support
 - i. IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)
 - j. RS-232
 - k. Contact closure input and output
 - l. Dante Protocol
9. Control capacity
 - a. DMX Universes: 63,999 sACN Universes (8 universes on non-networked DMX-512 port input/output per gateway)
 - b. Audio I/O: 64 input / 64 output
 - c. Video I/O: No hard limit; Networked video streams limited by system bandwidth
10. Rack Attributes:
 - a. Equipment rack shall be EIA compliant 19", steel cabinet.
 - b. Color: Powder coat black
 - c. Rackrail Type: 10-32

11. Physical attributes (rack)
 - a. Overall height: 68.25 in
 - b. Center section height: 65.38 in
 - c. Racking height: 61.25 in
 - d. Rack spaces: 35 SP
 - e. Weight capacity: 300 lbs
12. Electrical
 - a. 120Vac
 - b. (4) 20A dedicated circuits in (4) Quad Edison receptacles
 - c. 2600W
 - d. Internal 2000VA UPS system to power critical components in the event of a power failure or brownout.
13. Heat Generation
 - a. 8,840 BTU
14. Foot Print
 - a. From mounting surface: 39.6 in
 - b. Width: 47 in
 - c. Height: 68.25 in
15. Environmental
 - a. Operating temperature
 - 1) Minimum: 40 degrees Fahrenheit
 - 2) Maximum: 100 degrees Fahrenheit
 - b. Operating non-condensing humidity
 - 1) Minimum: 20 percent
 - 2) Maximum: 85 percent
 - c. Cooling method: Passive convection.

C. Touchscreen

- 1.Touchscreen stations shall consist of backlit LED display
 - a. Minimum viewable display size: 10.1 in
 - b. Minimum resolution: 1280x800
 - c. Bezel: Aluminum
 - d. Touch interface: Capacitive with LED backlight
 - e. Viewing angle: 170° horizontal and vertical
 - f. Finish: Black
 - g. Provide metal backbox and mounting frames
- 2.Electrical

- a. Powered device: 1 Watt via PoE
 - b. Integral RGB LED status indicator light
3. Input/Output:
- a. (2) RS-232 (Up to 115k Baud)
 - b. USB Type-C
 - c. IR (Bi-Directional)
 - d. RJ-45 10/100/1000M PoE (PD)
 - e. Digital I/O
 - 1) (2) with A/D capability
 - 2) Output Voltage: 5v
 - 3) Output Power: 17mA
 - 4) Input Max Voltage: 12VDC @ 500mW
 - f. Relay
 - 1) 2) Normally Open
 - 2) Max Current: 2A
4. Connect to control system using category 6 or better wire.
5. Master stations shall provide control of lighting processor presets, audio processor presets, video processor presets, sequences, fade times, macros, timeclock events, projector screen motor and interfaced external systems.
6. Master stations shall operate using graphic buttons, faders, and other images on programmable control pages.
7. Secondary stations capable of having customizable control pages that differ from the Master station.
8. Master and Secondary stations to have a QR code page enabling third party mobile devices to display and control the respective control pages.
9. There shall be at least 60 custom control pages available for programming and customization.
10. Status indication shall be tracked across all stations in real-time, including tracking of fades on graphical fader controls.
11. Stations shall allow programming of multiple-level passcodes, page lockout, and visibility. Touchscreen shall have the capability to program at least 10 passcodes with fully customizable control pages per passcode.
12. Passcode timeout lockout to be custom programmed.
13. Control pages shall include:
- a. unRAVL presets

- b. House lighting levels and presets
 - c. Theatrical lighting levels, presets, cues
 - d. Audio levels and presets
 - e. Video feed selection
 - f. System Tutorial
 - g. Student Education
 - h. Settings
14. Page layout and interface functionality shall be determined by the RAVL Consultant following approval of shop drawings. Programming services shall be provided by the Manufacturer.
15. Environmental
- a. Operating temperature
 - 1) Minimum: 40 degrees Fahrenheit
 - 2) Maximum: 100 degrees Fahrenheit
 - b. Operating non-condensing humidity
 - 1) Minimum: 20 percent
 - 2) Maximum: 85 percent
 - c. Cooling method: Passive convection.

D. Entry Stations

- 1. System snapshot, playback, preset, and fader wall station.
- 2. Connect to control system using category 6 or better wire.
- 3. Power coat variants:
 - a. White
 - b. Black
- 4. Variants:
 - a. Two Button
 - b. Four Button
 - c. One Slider
 - d. Two Slider
 - e. Three Slider
- 5. Mechanical
 - a. Housing
 - 1) Mounting:
 - i. Stainless steel single piece front plate
 - ii. Injection molded polycarbonate back box
 - 2) Stainless steel decorator wall plate powder coat variants:
 - i. Black.
 - ii. White.

- b. Mounting: 2 inches wide by 3 inches tall electrical box
 - 1) Maximum Wall Station Width: 6-insets
 - i. First Insert: 1 Primary
 - ii. Maximum Additional Insets: 5 Secondary
 - c. Ports
 - 1) Primary Variant
 - i. One 8-pin male header connector for Secondary Variant.
 - ii. One power over ethernet RJ45 jack.
 - 2) Secondary Variant
 - i. One 8-pin male header connectors.
6. Electrical
- a. Powered device: 1 Watt via PoE
 - b. Single-color integral LED status indicators:
 - 1) One activity.
 - 2) One link.
 - c. One tri-colored integral LED status indicator per button or slider.
7. Functional
- a. Standalone and independent operation
 - b. Maximum IP address based on networking architecture.
 - c. Configuration
 - 1) Configuration via unRAVL system computer.
 - i. Subsequent configuration via integral interface, specified herein.
 - 2) Priority Control: Highest Takes Precedence.
 - d. Primary Variant
 - 1) Connect via header with secondary variants.
 - 2) Button Variant
 - i. Independent playback of recorded scenes.
 - 1. Snapshot program.
 - 2. Record Allow
 - a. Is True: Push and hold individual button for 5 seconds to record current state.
 - b. Is False: Push and hold has no function.
 - 3) Slider Variant: Manual control of recorded scenes.
 - e. Secondary Variant
 - 1) Primary variant dependent.
 - 2) Connect via header with primary or secondary variants.
 - 3) Button Variant: Independent playback of recorded scenes.
 - 4) Slider Variant: Manual control of recorded scenes.

- f. Tri-color integral LED status indicator
 - 1) Button Variant
 - i. Amber: No sACN source found for selected universe.
 - ii. Dark Amber: Lock button configured, inactive.
 - iii. Light Amber: Lock button configured, active.
 - iv. Blue: Button is currently pressed and held.
 - v. Light Blue: Snapshot activated, in progress.
 - vi. Green: Snapshot recording complete.
 - vii. Grey: Inactive recorded snapshot.
 - viii. Magenta: Snapshot is overridden by slider.
 - ix. Red: Record Allow is true.
 - x. Dark Red: Record Allow is false.
 - xi. Pink: Priority override, active.
 - xii. Purple: Snapshot deactivated, in progress.
 - xiii. Seafoam: Priority override, inactive.
 - xiv. Teal: Snapshot activated to override current snapshot.
 - xv. Yellow: Deactivate snapshot.
 - 2) Slider Variant
 - i. Green: Grand master slider at full.
 - ii. Red: Grand master slider is not at full.
 - iii. White: Zone intensity as indicated.
 - g. Protocol: sACN
 - h. Slider variant: 256 programmable unique intensity states.
- 8.Environmental
- a. Operating temperature
 - 1) Minimum: 14 degrees Fahrenheit
 - 2) Maximum: 122 degrees Fahrenheit
 - b. Operating non-condensing humidity
 - 1) Minimum: 5 percent
 - 2) Maximum: 95 percent
 - c. Cooling method: Passive convection.
- E. Relay Panel
- 1.Connect to control system using category 6 or better wire.
 - 2.Outputs: [4] [8] [12] [16] [24] [32] [40] [48] Individual relays per panel, with an equal number of individual 0-10 V(dc) dimming outputs.
 - 3.Field Configurable Relays (FCR):
 - a. Field configurable to operate in single-, double-, or triple-pole relay groupings.
 - b. Field configurable to operate as normally closed or normally open.

- c. Provides visual status of current state and manual override control of each relay.
- d. Minimum Relay Contact Ratings:
 - 1) 40 A at 120-480 V(ac) Ballast.
 - 2) 16 A at 120-277 V(ac) Electronic.
 - 3) 20 A at 120-277 V(ac) Tungsten.
 - 4) 20 A at 48V (dc) Resistive.
 - 5) 2 HP at 120 V(ac).
 - 6) 3 HP at 240-277 V(ac).
 - 7) 65kA SCCR at 480 V(ac).
- 4. Dimming Output Rating: Minimum of 100 mA sink current per dimming output.
- 5. Relay and dimming outputs individually programmable.
- 6. Listing: UL 924 for control of emergency lighting circuits.
- 7. Power Supply: Integrated 120-277 V(ac) supply.
- 8. Low-Voltage Sensor Input:
 - a. Configurable to support any of the following input types:
 - 1) Indoor Photosensor.
 - 2) Outdoor Photosensor.
 - 3) Occupancy Sensor.
 - 4) Contact Closure.
 - b. Low-voltage sensor input provides 24 V(dc) power for sensor so additional auxiliary power supplies are not required.
 - c. Sensor input supports all standard sequence of operations.
- 9. Integrated Digital Time Clock for local schedule control.
- 10. Contact Closure Input: One for each group of eight output relays that acts as a panel override to activate the normally configured state of all associated relays (i.e., normally open or normally closed).
- 11. Panel supplies current limited low-voltage power to other networked devices connected via low-voltage network cable.
- 12. Enclosure:
 - a. Enclosure Rating: NEMA 1.
 - b. Mounting: [Surface] [Flush] mounted.
 - c. Cover: [Hinged cover with keyed lock] [Screw-fastened and plenum rated].

PART 3 – EXECUTION

1. PROTECTION OF EQUIPMENT

- a. It shall be the responsibility of the Electrical Contractor to receive, store, and protect the equipment in this section from damage and deterioration during all phases of work from the delivery of materials to the completed installation.

2. INSTALLATION

- a. The Electrical Contractor shall install system components as located on the architectural drawings. Installation shall be in accordance with architectural requirements, manufacturer's written instructions, TSI's shop drawings, recognized industry practice, applicable requirements of the National Electrical Code and UL standards, and in accordance with OSHA and local codes.
- b. The Electrical Contractor shall be licensed to operate as an Electrical Contractor in the state of New Jersey. The Electrical Contractor shall provide a copy of their License and an Insurance Certificate for this project.
- c. The Electrical Contractor shall be responsible for providing all bonding, job permits, and related fees as applicable.
- d. The Electrical Contractor shall be responsible for removal and disposal of all waste materials created by this installation process including but not limited to shipping and packaging materials, and items removed from existing system.
- e. The Electrical Contractor shall be responsible for all lifts, ladders, scaffolding and/or other devices required for the complete installation of this system.
- f. The Electrical Contractor shall be responsible for coordinating the installation, testing, and commissioning of the system with the Theatrical Systems Integrator.
- g. All load circuit conductors and data wiring for these systems shall be installed in a manner that is concealed above hung ceiling, below floors or in walls whenever possible and in metallic conduit, metal wireways, surface metal raceways, or other approved cable containment. Use of metal-sheathed or armored cable shall not be accepted without prior approval.
- h. All branch load circuits shall be live tested before connecting the loads to the dimmer system load terminals. Each circuit shall require separate neutrals.
- i. The Electrical Contractor shall not provide power to the Unified Rigging Audio Visual Lighting Control System until connections are site-verified by the Theatrical Systems Integrator.
- j. The Electrical Contractor shall be responsible for return visits by the Theatrical Systems Integrator due to incomplete or incorrect wiring or connections.
- k. The General Contractor shall be responsible for all painting and patching that may be required as a product of this installation process.

3. THEATRICAL SYSTEMS INTEGRATOR'S SERVICES

- a. The Theatrical Systems Integrator shall be responsible for the hanging, focusing, and addressing of the theatrical lighting fixtures.
 - b. The Theatrical Systems Integrator, with the assistance of the Electrical Contractor, shall be responsible for the tuning, adjusting, and programming of the audio and visual systems.
 - c. The Theatrical Systems Integrator shall be responsible for final testing of system functionality. The Electrical Contractor shall provide 21-day notice to schedule testing with the TSI upon completion of the installation.
 - d. Upon completion of installation, commissioning, and testing, the Theatrical Systems Integrator shall be responsible for demonstrating system operation to owner's representatives.
 - e. Upon completion of installation, commissioning, and testing, the Theatrical Systems Integrator shall be responsible for providing adequate training on system operation and maintenance to owner's representatives as per section [].03.06.
 - f. The Theatrical Systems Integrator shall be responsible for providing adequate training on system operation and maintenance to owner's representatives as per section [].03.06.
 - g. The Theatrical Systems Integrator shall be responsible for providing adequate guidance to accessing and administering student education resources as per section [].03.06.
4. COMMISSIONING
- a. Upon completion of commissioning, TSI shall demonstrate operation to owners representatives.
5. EDUCATION AND TRAINING
- a. System Training
 - i. Upon completion of the formal check-out, the Theatrical Systems Integrator shall demonstrate operation and maintenance of the system to the owner's representatives. Training session shall not exceed six working hours. For venues with motorized rigging, the training session shall not exceed eight working hours.
 - ii. Scheduling for training sessions shall be made in writing to the Theatrical Systems Integrator with at least 21-day notice prior to the date of system training.
 - iii. (2) additional 8-hour days of training and system maintenance with the Theatrical Systems Integrator are included as part of system warranty.

Training dates must be utilized within (3) years of date of completion of formal check-out.

- iv. System instructions including video and written documentation are to be accessible via Unified Rigging Audio Visual Lighting Control System touch panel controller.

b. Student Education Package

- i. At least twenty (20) hours of video content created for the sole purpose of student education is to be accessible to cast on projection screen via Unified Rigging Audio Visual Lighting Controls touchpanel control presets.
- ii. Student education content to be designed in accordance to the curriculum for the United States Institute for Theatre Technology BACKstage Examination and is to be instructed by credentialed industry professionals.
- iii. Content designed as manufacturer technology overview or manufacturer technology instructions as utilized for marketing or industry professional instruction will not be accepted.
- iv. TSI shall provide training to owner's representatives for video access and BACKstage examination registration.

6. WARRANTY AND SERVICE

a. System Warranty

- i. Manufacturers shall warrant Unified Rigging Audio Visual Lighting System products under normal use and service to be free from defects in functionality for a period of two (2) years from date of delivery.
- ii. Warranty shall cover repair or replacement of such parts determined defective upon inspection.
- iii. Installation shall be warranted by the installing contractor as required by the project specifications.
- iv. Warranty shall not cover any labor expended or materials used to repair any equipment without manufacturer's prior written authorization.
- v. Warranty does not cover any product or part of a product subject to accident, negligence, alteration, abuse, or misuse.
- vi. Warranty does not cover any accessories or parts not supplied by the manufacturer.

END OF SECTION 190500

SECTION 220500 – GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and all Division 22 Sections.

1.2 PLANS AND SPECIFICATIONS

- A. All work under this title, on drawings or specified, is subject to the general and special contract conditions for the entire project, and the contractor for this portion of the work is required to refer especially thereto, and to the architectural drawings.
- B. Drawings are diagrammatic and specifications are complementary and must be so interpreted to determine the full scope of work under this heading. Wherever any material, article, operation or method is either specified or shown on the drawings, this contractor is required to provide each item and perform each prescribed operation according to the designate quality, qualification or condition, furnishing all necessary labor, equipment or incidentals.
- C. Wherever the designation "Architect" appears, it shall imply Architect or Engineer. Wherever the term "Contractor" or "PC" appears, it shall imply the Contractor responsible for Division 22, Plumbing Work.

1.3 CONFLICTS

- A. If, in the interpretation of contract documents, it appears that the drawings and specifications are not in agreement, the Contractor is to contact the Engineer. The Engineer shall be the final authority. Addenda supersede the provisions which they amend.
- B. In the absence of a written clarification by the engineer, the Contractor must install his work in accordance with the more stringent condition. Contractor assumes full responsibility for any and all items furnished and installed without the written approval by the Architect or Engineer.

1.4 DIMENSIONS, LAYOUTS AND OBSTACLES

- A. Verify dimensions and elevations from actual field measurements after building construction has sufficiently progressed.
- B. Assume full and final responsibility for the accuracy of any or all work performed under this Division and make repairs and corrections as required or directed at no extra cost to the Owner.
- C. Layouts of piping and equipment shown on drawings are diagrammatic and shall be construed as such. DO NOT SCALE DRAWINGS. Contractor shall field verify all existing conditions prior to fabrication and installation of material. It is recommended that the contractor verify all existing conditions prior to submitting a proposal. Lack of field verification does not constitute a basis for additional monies during construction. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.
- D. Make actual installations in accord with said layouts, but with necessary deviations as directed or required by job conditions and field measurements in order to produce a thoroughly integrated and practical installation. . Make deviations only with specific approval of the Engineer/Architect.
- E. Take particular care to coordinate all work under this Division to prevent conflict and remove and relocate work as may be made necessary by such conflict at no extra cost to the Owner.
- F. Unless expressly permitted by the Engineer/Architect or shown otherwise on the Drawings, all piping and similar items shall be installed so that they are concealed except as permitted by the Engineer/Architect in service rooms noted on the Drawings.
- G. Fixtures and equipment may be relocated six (6) feet in any direction from locations indicated on plans, before roughing-in, with no change in contract price.

1.5 REVIEW OF MATERIAL

- A. Items specified have been checked by the Engineer for performance and space limitation.
- B. In order for Engineer to consider "equal", Contactor must certify by letter that he has checked the product for conformance to specifications and space limitations and assumes full responsibility thereafter.

- C. Substitutions are defined as any manufacturer and/or model not indicated in drawings or specifications. Requests for substitutions must be made in writing ten (10) days prior to bid date so that an addendum may reach all contractors.
- D. If substitutions are proposed after the bids are received, the Contractor shall state amount of credit to the Owner for substitution. Substitutions that are considered equal by the Contractor and carried in bid without approval by Engineer shall be the responsibility of the Contractor. The Engineer and/or Owner shall not be made liable or responsible for losses incurred by the Contractor, due to the rejection of said items for installation.
- E. Where equipment requiring different arrangement or connections other than as indicated is acceptable, it shall be the responsibility of this Contractor to furnish revised layouts, and install the equipment to operate properly and in harmony with the intent of the drawings and specifications. All changes in the work required by the different arrangement shall be done at no additional cost to the Owner, including but not limited to structural steel modifications. Control and power wiring modifications required by Contractor, imposed modifications, and the additional cost of these modifications, shall be the responsibility of this Contractor.

1.6 PERMITS, CODES AND ORDINANCES

- A. The Contractor shall arrange and pay for all permits, inspections, etc., as required by local utilities or applicable agencies.
- B. All work and material shall be in complete accordance with the ordinances, regulations, codes, etc., of all political entities exercising jurisdictions.

1.7 COORDINATION WITH OTHER TRADES

- A. Check plumbing work with all other trades.
- B. Anticipate and avoid interferences with other trades.
- C. Take particular care to coordinate all piping, ductwork, plumbing and major electrical components above ceiling, to prevent conflict. Remove and relocate work as may be made necessary by such conflict, at no extra cost to the Owner.
- D. Obtain decision for approval from project Engineer for proposed group installation before proceeding, and for clearance in structure and finish of the building.
- E. Running piping over electrical equipment and in elevator machine rooms is prohibited.

- F. The Contractor shall coordinate with, receive and install, Owner furnished equipment where indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials: Make provisions for delivery and safe storage of all materials. Check and properly receipt material to be "furnished by others" to contractor and assume full responsibility for all materials while in storage with full visible identification and information.

1.9 PROJECT CONDITIONS

- A. Coordination: Field verify existing conditions that will determine exact locations, distances, levels, dimensions, elevations, etc. Review all drawings of other trades and report any conflicts to the Architect/Engineer which will affect the project cost. Lack of field verification does not constitute a basis for additional monies during construction. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.

1.10 MISCELLANEOUS SUPPORT

- A. Contractor is responsible for providing all miscellaneous support components necessary for properly supporting equipment including hangers, rods, anchors, steel, etc. PRODUCTS (not used)

PART 2 - EXECUTION

2.1 INSTALLATION

- A. Comply with manufacturer's written installation, operations and maintenance instructions for general installation requirements and procedures.

END OF SECTION 220500

SECTION 220502 - PLUMBING DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Description of Work: Provide plumbing removal work as indicated and as required for removal and/or abandonment of systems, equipment and fixtures, etc. made obsolete by this Project, and as required for removal and remodeling by other trades.

1.2 EXISTING CONDITIONS

- A. General: In general, existing plumbing systems, equipment and fixtures are not shown on the Drawings unless pertinent to the demolition and/or remodeling work. Existing conditions, where indicated, are based on casual field observations and/or historical plans prepared as part of original building fit-out, and must be verified. Report any discrepancies to the Engineer before disturbing the existing installation.
- B. Examination: Prior to bidding, examine the site to determine all actual observable conditions. No additional compensation will be granted on account of extra work made necessary by the Contractor's failure to investigate such existing conditions.

1.3 COORDINATION

- A. Adjoining Areas: It is expected that the Contractor understands that adjoining areas of the building (or project site) must remain in operation and mechanical systems and services must remain in operation at all times, unless specifically approved otherwise.
- B. Scheduling: Plumbing removal work shall be scheduled in conjunction with the other trades. Contractor cooperation will be expected under all conditions.
- C. Area Limits: Construction traffic and removal of debris will be limited to specific areas and routes. Confirm with the Owner.

1.4 ADJACENT MATERIALS

- A. Protection: During execution of removal work, primary consideration shall be given to protecting from damage, building structure, furnishings, finishes and the like, which are not specifically indicated to be removed.

- B. Repairs: Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Owner, at no cost to the Contract.

1.5 TRANSIENT SERVICES

- A. Locate and identify any and all plumbing services passing through the project area which serve areas outside the work limits.
- B. Maintain all plumbing services to areas outside the work limits unless specifically authorized otherwise in writing by the Engineer or Owner's Representative. When transient services must be interrupted, provide temporary services for affected areas outside the work limits.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described, but required for proper completion of the Work, they shall be as selected by the Contractor, subject to approval of the Engineer.

PART 3 - EXECUTION

3.1 INSPECTION/VERIFICATION

- A. Inspection: Before commencing work of this Section, carefully inspect the project site and become familiar with existing systems and conditions.
- B. Items to be Salvaged: Verify with the Engineer and Owner's Representative, all systems, materials and equipment which are to be salvaged, and those which must be removed. The Owner reserves the right to salvage any or all existing plumbing materials and equipment at the project site.

3.2 COORDINATION

- A. Coordinate removal work with other trades, where applicable.

3.3 DEMOLITION

- A. General: Remove plumbing equipment, piping, fixtures and related materials within the project work limits, as indicated.
- B. Disconnections: Disconnect all plumbing work located in walls, ceilings or floors scheduled for removal. Disconnect plumbing connections equipment being removed by other trades.
- C. Protection: Perform all removal work in such a manner so that damage to adjacent items and surfaces is minimized.
- D. Patching: When plumbing materials are removed, patch and finish surfaces to remain to match surrounding surfaces.

3.4 EXISTING PLUMBING WORK TO REMAIN

- A. General: Protect and maintain access to existing plumbing work which must remain. Reinstall existing plumbing work where disturbed.
- B. Reconnections: Where plumbing work in adjoining areas or plumbing work indicated to remain, becomes disconnected or affected by demolition work, reconnect as required, to restore original operation. Restoration work to comply with requirements for new work.

3.5 EXISTING PLUMBING WORK TO BE RELOCATED

- A. General: Disconnect, remove, reinstall and reconnect existing equipment indicated to be relocated and where require to accommodate remodeling or new construction. Extend existing installations as required. Materials and methods used for relocations and extensions to conform to requirements for new work.

3.6 SHUTDOWNS

- A. General: All shutdowns to existing plumbing services to be scheduled and approved, in writing, by the Owner.

3.7 DISPOSITION OF EXISTING MATERIALS AND EQUIPMENT

- A. Items to Salvage: Material and equipment which is indicated (or directed by Owner) to be salvaged, shall be carefully removed and stored where directed on the site.

- B. Items to Reuse/Relocate: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to installation.
- C. Items to Remove: Remove and legally dispose of all other materials and debris resulting from demolition work on a daily basis.

3.8 CLEANING

- A. Remove from the Project Site all dirt, dust and debris resulting from removal operations daily. Refuse shall not be allowed to block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION 220502

SECTION 220529 – SUPPORTS AND SLEEVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Perform all Work required to provide and install supports, hangers, anchors, sleeves and bases for all pipe, duct, equipment, system components and accessories, indicated by the Contract Documents with all supplementary items necessary for complete, code compliant and approved installation

1.2 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - 1. International Plumbing Code.
 - 2. International Fuel Gas Code.
 - 3. ASME B31.2 – Fuel Gas Piping.
 - 4. ASME B31.9 – Building Services Piping.
 - 5. ASTM F708 – Design and Installation of Rigid Pipe Hangers.
 - 6. MSS SP58 – Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 7. MSS SP69 – Pipe Hangers and Supports - Selection and Application.
 - 8. MSS SP89 – Pipe Hangers and Supports - Fabrication and Installation Practices.
 - 9. MSS SP-90 – Guidelines on Terminology for Pipe Hangers and Supports.

1.3 QUALITY ASSURANCE

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS-SP-58 and SP-69 unless noted otherwise.

- B. Support and sleeve materials and installation shall not interfere with the proper functioning of equipment.
- C. Contractor shall be responsible for structural integrity of all hangers, supports, anchors, guides, inserts and sleeves. All structural hanging materials shall have a minimum safety factor of five.
- D. Installer Qualifications: Utilize an installer experienced in performing Work of this Section who is experienced in installation of Work similar to that required for this Project and per the minimum requirements of MSS SP-89. Field welding of supports shall be by certified welders qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX using welding procedures per the minimum requirements of MSS SP-58.

1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog data including code compliance, load capacity, and intended application.
- B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.
- C. Shop Drawings: Submit detailed Drawings of all shop or field fabricated supports, anchors and sleeves, signed and sealed by a qualified State of New York registered professional engineer. Indicate size and characteristics of components and fabrication details and all loads exceeding 750 pounds imposed on the base building structure.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Maintain in place until installation.
- C. Store materials protected from exposure to harmful weather conditions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 MANUFACTURERS

- A. Hangers and Supports:
 - 1. Anvil International.
 - 2. Kinder.
 - 3. Cooper B-Line.
 - 4. C & S Mfg. Corp.
 - 5. Hubbard Enterprises/Holdrite.
 - 6. National Pipe Hanger Corporation.
 - 7. Power Strut.

2.3 HANGERS AND SUPPORTS

- A. General:
 - 1. Refer to individual system and equipment Specification Sections for additional support requirements. Comply with MSS SP-69 for support selections and applications that are not addressed within these Specifications.
 - 2. Utilize hangers and supports to support systems under all conditions of operation, allowing free expansion and contraction, and to prevent excessive stresses from being introduced into the structure, piping or connected equipment.
 - 3. All pipe supports shall be of the type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
 - 4. Design hangers to impede disengagement by movement of supported pipe.
 - 5. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in

- MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.
6. Wire or perforated strap iron will not be acceptable as hanger material.
 7. Hanger rods shall be threaded on both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
 8. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation are not acceptable.
 9. Plastic anchors or plastic expansion shields will not be permitted under any circumstances.
 10. Hangers and clamps supporting and contacting individual non-insulated brass or copper lines shall be copper or copper plated. Where non-insulated brass or copper lines are supported on trapeze hangers or channels, the pipes shall be isolated from these supports with approved flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp. Plastic tape is not acceptable.
 11. Hangers and clamps supporting and contacting glass piping shall be in accordance with the piping manufacturer's published recommendations and shall be fully lined with minimum 1/4 inch neoprene padding. The padding material and the configuration of its installation shall be submitted for approval.
 12. Hangers and clamps supporting and contacting plastic piping shall be in accordance with the piping manufacturer's published recommendations and shall be factory coated or padded to prevent damage to piping.
 13. Field fabricated supports shall be constructed from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- B. Finishes: All ferrous hangers, rods, inserts, clamps, stanchions, and brackets on piping within interior non-corrosive environments, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. All hangers and supports exposed to the weather, including roofs and building crawl space areas, shall be galvanized or manufactured from materials that will not rust or corrode due to moisture.
- C. Vertical Piping:

1. Supports for vertical riser piping in concealed areas shall utilize double bolt riser clamps, with each end having equal bearing on the building structure at each floor level.
 2. Supports for vertical riser piping at floor levels in exposed areas shall be attached to the underside of the penetrated structure utilizing drilled anchors, two hanger rods (sized as specified), and socket clamp with washers.
 3. Two-hole rigid pipe clamps or four-hole socket clamps with washers may be used to support pipe directly from adequate structural members where floor-to-floor distance exceeds required vertical support spacing and lines are not subject to expansion and contraction.
- D. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on manufactured channel, suspended on rods or pipes. Trapeze members including suspension rods shall be properly sized for the quantity, diameters, and loaded weight of the lines they are to support.
- E. Fixture and Equipment Service Piping:
1. Piping at local connections to plumbing fixtures and equipment shall be supported to prevent the weight of the piping from being transmitted to fixtures and equipment.
 2. Makeshift, field-devised methods of plumbing pipe support, such as with the use of scrap framing materials, are not allowed. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96. These shall be Hubbard Enterprises/Holdrite support systems, C & S Mfg. Corp. or approved equivalent.
 3. Supports within chases and partitions shall be corrosion resistant metal plate, clamps, angles or channels, and aligned with structure in the vertical or horizontal position. Plastic supports are not allowed without written approval.
 4. Horizontal supports within chases and partitions that are attached to studs shall be attached at both ends. Drywall shall not be relied upon to support the piping.
 5. Supports for plumbing fixture water service piping within chases and partitions may be attached to cast iron drain and vent pipe with approved brackets and pipe clamps.
 6. Piping exposed on the face of drywall shall be supported with corrosion resistant metal channels that are attached to wall studs. Drywall shall not be relied upon to support the piping.

7. Piping supported from the floor shall utilize corrosion resistant metal channels or brackets that are anchored to the floor slab.
8. All water piping shall be isolated from building components to prevent the transmission of sound.
9. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action. Plastic tape is not an acceptable isolation material.

F. Inserts:

1. Cast-in-place concrete inserts shall comply with MSS-SP-69, U.L. and F.M. approved, and sized to suit threaded hanger rods.
2. Inserts shall have malleable iron case with galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval.
3. Manufactured inserts for metal deck construction shall have legs custom fit to rest in form valleys.
4. Shop fabricated inserts shall be submitted and approved by Owner prior to installation.
5. Inserts shall be of a type that will not interfere with structural reinforcing and that will not displace excessive amounts of structural concrete.

- G. Pipe Shields: Provide pipe shields in accordance with insulation manufacturer's published recommendations. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier.

H. Housekeeping Pads:

1. Provide minimum 4 inch reinforced concrete pads with chamfered corners and equipment bases for all outdoor equipment on grade, floor mounted equipment in main central plant area, mechanical rooms, areas with floors below grade, penthouse equipment rooms, floor mounted air handling units, and where shown on Drawings.

2. Housekeeping pads shall extend minimum of 4 inch on all sides beyond the limits of the mounted equipment unless otherwise noted.
3. Provide galvanized anchor bolts for all equipment placed on concrete pads or on concrete slabs of the size and number recommended by the equipment manufacturer.

2.4 THROUGH PENETRATIONS

A. General:

1. Seal penetrations through all rated partitions, walls and floors with U.L. tested assemblies to provide and maintain a rating equal to or greater than the partition, wall or floor.
2. Inside diameter of all sleeves or cored holes shall provide sufficient annular space between outside diameter of pipe or insulation to allow proper installation of required fire and water proofing materials and allow for movement due to expansion and contraction.
3. Exposed ceiling, floor and wall pipe penetrations within finished areas (including exterior wall faces) shall be provided with chrome plated, brass or stamped steel, hinged, split-ring escutcheon with set screw or snap-on type. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings. In exterior, damp, or corrosive environments, use Type 302 stainless steel escutcheons.

B. Floor Pipe Penetrations:

1. Seal penetrations through all floors to provide and maintain a watertight installation.
2. Sleeves cast in the slab for pipe penetrations shall be Schedule 40 steel, ASTM A53, with 2 inch wide annular fin water-stop continuously welded at midpoint. Entire assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.
3. Cored holes in the slab for pipe penetrations shall be provided with a Schedule 40 steel, ASTM A53, sleeve with 2 inch wide annular fin water-stop continuously welded at point on sleeve to allow countersinking into slab and waterproofing. Entire sleeve assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.
4. All sleeves shall extend a minimum of two inches above finished floor.

5. Where job conditions prevent the use of a sleeve that extends two inches above the slab, Link-Seal mechanical casing seals manufactured by Thunderline Corporation may be installed to provide a watertight penetration. Mechanical casing seals can be used only for relatively small diameter pipe penetrations. Verify that slab thickness allows proper installation of the link-seal assembly and the required fire stopping prior to applying this exception.

C. Wall Penetrations:

1. Where piping passes through non-rated partition, close off space between pipe and construction with gypsum wallboard and repair plaster smoothed and finished to match adjacent wall area.
2. Pipe penetrations through interior rated partitions shall be provided with adjustable prefabricated U.L. listed fire rated galvanized sheet metal sleeves having gauge thickness as required by wall fire rating, 20 gauge minimum. EXCEPTION: When U.L. Listed assembly does not require a sleeve,
3. Pipe penetrations through exterior walls and walls below grade shall be provided with "Link-Seal" mechanical casing seal manufactured by Thunderline Corporation.

D. Flashing:

1. Coordinate flashing material and installation required for pipe roof penetrations with Owner and roofing Contractor.
2. Provide acoustical flashing around pipes penetrating equipment rooms, with materials and installation in accordance with manufacturer's instructions for sound control.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Conduct a pre-installation meeting prior to commencing Work of this Section to verify Project requirements, coordinate with other trades, establish condition and completeness of substrate, review manufacturer's installation instructions and manufacturer's warranty requirements.

3.2 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. Application, sizing and installation of piping, supports, anchors and sleeves shall be in accordance with manufacturer's printed installation instructions.
- C. Provide for vertical adjustments after erection and during commissioning, where feasible, to ensure pipe is at design elevation and slope.
- D. Install hangers and supports to allow controlled thermal movement of piping systems, permitting freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Install hanger so that rod is vertical under operating conditions.
- F. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.
- G. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete that holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required. Contractor shall be responsible for engaging a structural engineer as required for design and review at support systems.
- H. Do not hang pipe or any item directly from a metal deck or locate on the bottom chord of any truss or joist unless approved by the Structural Engineer of Record.
- I. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc.
- J. Piping supports shall be independent from other supports. Combining supports is not permitted.
- K. Provide all supporting steel required for the installation of plumbing equipment and materials, including angles, channels, beams, etc. to suspended or floor

supported tanks and equipment. All of this steel may not be specifically indicated on the Drawings.

- L. Piping supports shall be designed and installed to allow the insulation to be continuous through the hangers.
- M. Adjustable clevis hangers shall be supported at rods with a nut above and below the hanger.
- N. All hanger rods shall be trimmed neatly so that 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the Contractor shall take appropriate measures to protect the pipe or other materials from damage.
- O. Install hangers to provide minimum ½ inch space between finished covering and adjacent structures, materials, etc.
- P. Horizontal and vertical piping in chases and partitions shall be supported to prevent movement and isolated from the supports to prevent transmission of sound.
- Q. Locate hangers within 12 inches of each horizontal elbow.
- R. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- S. Support riser piping independently of connected horizontal piping. Riser piping is defined as vertical piping extending through more than one floor level.
- T. Support riser piping at each floor level and provide additional supports where floor-to-floor distance exceeds required vertical support spacing. Installation of riser clamps and welded steel riser supports shall not allow weight of piping to be transmitted to floor sleeves.
- U. Steel Bar Joists: Hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded or otherwise permanently fixed to the top of joists.
- V. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.

W. 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.

X. Flashing:

1. Coordinate all roof flashing with requirements of Division 07.

Y. Pipe Shields:

1. Provide shields at each hanger supporting insulated pipe.
2. Provide shields of the proper length to distribute weight evenly and to prevent compression of insulation at hanger.
3. Install shield so that hanger is located at the center of the shield.
4. Attach shield to insulation with adhesive to prevent slippage or movement.

Z. Equipment Anchor Bolts:

1. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of sufficient size to provide 1/2 inch clearance around bolt.

END OF SECTION 220529

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SECTION 220553 – PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.2 ACTION SUBMITTALS

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

1.3 COORDINATION

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

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

2. Letter Color: White
 3. Background Color: Black
 4. Maximum Temperature: Able to withstand temperatures up to 180 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White
- C. Background Color: Red
- D. Maximum Temperature: Able to withstand temperatures up to 180 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately

larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

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

2.4 VALVE TAGS

- A. Valve Tags: 1-1/2 inch diameter, stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

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

3.3 VALVE TAG INSTALLATION

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

END OF SECTION 220553

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SECTION 221613 – NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 3. Pressure regulators. Indicate pressure ratings and capacities.
 - 4. Dielectric fittings.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For motorized gas valves and pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Owner no fewer than five (5) days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
6. Mechanical Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dresser Piping Specialties; Division of Dresser, Inc.
 - 2) Smith-Blair, Inc.
 - b. Stainless-steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Stainless-steel bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.2 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 VALVES

- A. All valves shall be designed, manufactured and approved for natural gas service.
- B. Line Shut-off Valves sizes 2 inches and smaller shall be iron body lubricated plug valve conforming to ASTM-A-126, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, wrench operation, rated for 200 WOG service pressure and -20 to 200 degrees F., manufactured by Resun Model R-1430 or Nordstrom Model 142.
- C. Line Shut-off Valves sizes 2½ inches and larger shall be iron body lubricated plug valve conforming to ASTM-A-126, U.L. Listed and A.G.A. Approved for natural gas service with flanged ends, wrench operation, rated for 200 WOG service pressure and -20 to 200 degrees F., manufactured by Resun Model R-1431 or Nordstrom Model 143.
- D. Appliance/Equipment Shut-off Valves at local connections sizes 2 inches and smaller shall be bronze body, full port ball or butterfly type, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, quarter turn lever handle operation, rated for 175 W.O.G. service pressure and 30 to 275 degrees F., manufactured by Nibco Model T585-70-UL, Model T580-70-UL or Milwaukee Model BB2-100.

2.4 PRESSURE REGULATORS

- A. General Requirements:
 - 1. Single stage and suitable for natural gas.
 - 2. Steel jacket and corrosion-resistant components.
 - 3. Elevation compensator.
 - 4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Line Pressure Regulators: Comply with ANSI Z21.80.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

- a. Actaris.
 - b. American Meter Company.
 - c. Eclipse Combustion, Inc.
 - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - e. Invensys.
 - f. Maxitrol Company.
 - g. Richards Industries; Jordan Valve Div.
 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
 10. Overpressure Protection Device: Factory mounted on pressure regulator.
 11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 12. Maximum Inlet Pressure: 2 psig
- C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - a. Canadian Meter Company Inc.
 - b. Eaton Corporation; Controls Div.
 - c. Harper Wyman Co.
 - d. Maxitrol Company.
 - e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 1 psig

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 3. Replace pipe having damaged PE coating with new pipe.
- C. Install fittings for changes in direction and branch connections.

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.

- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or

electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors.
- W. Install sleeve seals for piping penetrations of concrete walls and slabs.

3.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.

- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 220529 – Supports and Sleeves.
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.7 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 220553 - Plumbing Identification for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

- B. Paint exposed, exterior metal piping, valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (semigloss).
 - d. Color: Yellow.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 NATURAL GAS PIPING SCHEDULE

- A. Aboveground natural-gas piping, NPS 2 and smaller, shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground natural-gas piping, NPS 2-1/2 and larger, shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.

END OF SECTION 221613

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SECTION 230500 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and all Division 23 Sections.

1.2 PLANS AND SPECIFICATIONS

- A. All work under this title, on drawings or specified, is subject to the general and special contract conditions for the entire project, and the contractor for this portion of the work is required to refer especially thereto, and to the architectural drawings.
- B. Drawings are diagrammatic and specifications are complementary and must be so interpreted to determine the full scope of work under this heading. Wherever any material, article, operation or method is either specified or shown on the drawings, this contractor is required to provide each item and perform each prescribed operation according to the designate quality, qualification or condition, furnishing all necessary labor, equipment or incidentals.
- C. Wherever the designation "Architect" appears, it shall imply Architect or Engineer. Wherever the term "Contractor" or "MC" appears, it shall imply the Contractor responsible for Division 23, Mechanical Work.

1.3 CONFLICTS

- A. If, in the interpretation of contract documents, it appears that the drawings and specifications are not in agreement, the Contractor is to contact the Engineer. The Engineer shall be the final authority. Addenda supersede the provisions which they amend.
- B. In the absence of a written clarification by the engineer, the Contractor must install his work in accordance with the more stringent and/or costly condition. Contractor assumes full responsibility for any and all items furnished and installed without the written approval by the Architect or Engineer. Under no circumstances will a change order be approved for work installed that was not approved by the Architect or Engineer.

1.4 DIMENSIONS, LAYOUTS AND OBSTACLES

- A. Verify dimensions and elevations from actual field measurements after building construction has sufficiently progressed.
- B. Assume full and final responsibility for the accuracy of any or all work performed under this Division and make repairs and corrections as required or directed at no extra cost to the Owner.
- C. Layouts of piping, ductwork, and equipment shown on drawings are diagrammatic and shall be construed as such. **DO NOT SCALE DRAWINGS.** Contractor shall field verify all existing conditions prior to fabrication and installation of material. It is recommended that the contractor verify all existing conditions prior to submitting a proposal. Lack of field verification does not constitute a basis for additional monies during construction. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.
- D. Make actual installations in accord with said layouts, but with necessary deviations as directed or required by job conditions and field measurements in order to produce a thoroughly integrated and practical job upon completing, but make deviations only with specific approval of the Engineer/Architect.
 - 1. Take particular care to coordinate all piping and ductwork under this Division to prevent conflict and remove and relocate work as may be made necessary by such conflict at no extra cost to the Owner.
 - 2. Unless expressly permitted by the Engineer/Architect or shown otherwise on the Drawings, all piping, ducts and similar items shall be installed so that they are concealed except as permitted by the Engineer/Architect in service rooms noted on the Drawings.
- E. The Owner or Owner's Representative reserves the right to relocate terminal equipment six (6) feet in any direction from locations indicated on plans, before roughing-in, with no change in contract price.

1.5 REVIEW OF MATERIAL

- A. Items specified have been checked by the Engineer for performance and space limitation.
- B. In order for Engineer to consider "equal", Contractor must certify by letter that he has checked the product for conformance to specifications and space limitations and assumes full responsibility thereafter.
- C. Engineer, not Contractor or Vendor, shall be the final judge of equal materials.

- D. Substitutions are defined as any manufacturer and/or model not indicated in drawings or specifications. Requests for substitutions must be made in writing ten (10) days prior to bid date so that an addendum may reach all contractors.
- E. If substitutions are proposed after the bids are received, the Contractor shall state amount of credit to the Owner for substitution. Substitutions that are considered equal by the Contractor and carried in bid without approval by Engineer shall be the responsibility of the Contractor. The Engineer and/or Owner shall not be made liable or responsible for losses incurred by the Contractor, due to the rejection of said items for installation.
- F. Where equipment requiring different arrangement or connections other than as indicated is acceptable, it shall be the responsibility of this Contractor to furnish revised layouts, and install the equipment to operate properly and in harmony with the intent of the drawings and specifications. All changes in the work required by the different arrangement shall be done at no additional cost to the Owner, including but not limited to structural steel modifications. Control and power wiring modifications required by Contractor, imposed modifications, and the additional cost of these modifications, shall be the responsibility of this Contractor.
- G. Upon review of equipment list by Engineer, copies of submittal prints shall be forwarded to Engineer within 30 days.

1.6 PERMITS, CODES AND ORDINANCES

- A. The Contractor shall arrange and pay for all permits, inspections, etc., as required by local utilities or applicable agencies.
- B. All work and material shall be in complete accordance with the ordinances, regulations, codes, etc., of all political entities exercising jurisdictions, specifically including the NYS Energy Code.

1.7 COORDINATION WITH OTHER TRADES

- A. Check mechanical drawings with all other trades including electrical, plumbing, fire protection and general construction.
- B. Anticipate and avoid interferences with other trades.
- C. Take particular care to coordinate all piping, ductwork, plumbing and major electrical components above ceiling, to prevent conflict. Remove and relocate work as may be made necessary by such conflict, at no extra cost to the Owner. The use of coordination drawings is recommended but may not be required (refer to Division 1 for additional requirements). Lack of coordination drawings assumes contractor has verified and coordinated all work associated with installation.

- D. Obtain decision for approval from project Engineer for proposed group installation before proceeding, and for clearance in structure and finish of the building.
- E. Verify with drawings all ductwork and equipment layout in concealed areas.
- F. Running pipe and ductwork over electrical equipment and in elevator machine rooms is prohibited.
- G. The Contractor to coordinate with, receive and install, Owner furnished equipment where indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials: Make provisions for delivery and safe storage of all materials. Check and properly receipt material to be "furnished by others" to contractor, and assume full responsibility for all materials while in storage with full visible identification and information.

1.9 PROJECT CONDITIONS

- A. Existing Conditions: Field verify existing conditions that will determine exact locations, distances, levels, dimensions, elevations, etc. Review all drawings of other trades and report any conflicts to the Architect/Engineer which will affect the project cost. Lack of field verification does not constitute a basis for additional monies during construction. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.
- B. The existing facility will be occupied and functioning during the entire duration of construction. Care shall be taken when working in or around occupied spaces. There will be no interruption in mechanical systems or utilities without written approval from the Owner.

1.10 MISCELLANEOUS SUPPORT

- A. Mechanical Contractor is responsible for providing all miscellaneous support components necessary for properly supporting equipment including hangers, rods, anchors, steel, etc.

END OF SECTION 230500

SECTION 230502 - MECHANICAL DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Description of Work: Provide mechanical removal work as indicated and as required for removal and/or abandonment of systems, equipment and devices, etc. made obsolete by this Project, and as required for removal and remodeling by other trades.

1.2 EXISTING CONDITIONS

- A. General: In general, existing mechanical systems, equipment and devices are not shown on the Drawings unless pertinent to the demolition and/or remodeling work. Existing conditions, where indicated, are based on casual field observations and/or historical plans prepared as part of original building fit-out, and must be verified. Report any discrepancies to the Engineer before disturbing the existing installation.
- B. Examination: Prior to bidding, examine the site to determine all actual observable conditions. No additional compensation will be granted on account of extra work made necessary by the Contractor's failure to investigate such existing conditions.

1.3 COORDINATION

- A. Adjoining Areas: It is expected that the Contractor understands that adjoining areas of the building (or project site) must remain in operation and mechanical systems and services must remain in operation at all times, unless specifically approved otherwise.
- B. Scheduling: Mechanical removal work shall be scheduled in conjunction with the other trades. Contractor cooperation will be expected under all conditions.
- C. Area Limits: Construction traffic and removal of debris will be limited to specific areas and routes. Confirm with the Owner.

1.4 ADJACENT MATERIALS

- A. Protection: During execution of removal work, primary consideration shall be given to protecting from damage, building structure, furnishings, finishes and the like, which are not specifically indicated to be removed.
- B. Repairs: Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Owner, at no cost to the Contract.

1.5 TRANSIENT SERVICES

- A. Locate and identify any and all mechanical services passing through the project area which serve areas outside the work limits.
- B. Maintain all mechanical services to areas outside the work limits unless specifically authorized otherwise in writing by the Engineer or Owner's Representative. When transient services must be interrupted, provide temporary services for affected areas outside the work limits.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described, but required for proper completion of the Work, they shall be as selected by the Contractor, subject to approval of the Engineer.

PART 3 - EXECUTION

3.1 INSPECTION/VERIFICATION

- A. Inspection: Before commencing work of this Section, carefully inspect the project site and become familiar with existing systems and conditions.
- B. Items to be Salvaged: Verify with the Engineer and Owner's Representative, all systems, materials and equipment which are to be salvaged, and those which must be removed. The Owner reserves the right to salvage any or all existing mechanical materials and equipment at the project site. Items to be salvaged include, but are not limited to, the following:
 - 1. Albert Leonard Middle School
 - a. Exhaust Fans for reinstallation
 - 2. Columbus Elementary School
 - a. Ductless split system in main office – turn over to Owner.
 - 3. Trinity Elementary School
 - a. Exhaust Fans for reinstallation
 - b. Rooftop Unit for reinstallation
 - c. Condensing Units for reinstallation

3.2 COORDINATION

- A. Coordinate removal work with other trades, where applicable.

3.3 DEMOLITION

- A. General: Remove mechanical equipment, ductwork, piping, controls and related materials within the project work limits, as indicated.
- B. Disconnections: Disconnect all electrical devices and equipment located in wall, ceilings or floors scheduled for removal and other equipment, as indicated. Disconnect electrical connections to mechanical and other equipment being removed by other trades.
- C. Protection: Perform all removal work in such a manner so that damage to adjacent items and surfaces is minimized.
- D. Patching: When mechanical materials are removed, patch and finish surfaces to remain to match surrounding surfaces.

3.4 EXISTING MECHANICAL WORK TO REMAIN

- A. General: Protect and maintain access to existing mechanical work which must remain. Reinstall existing mechanical work disturbed.
- B. Reconnections: Where mechanical work in adjoining areas or mechanical work indicated to remain, becomes disconnected or affected by demolition work, reconnect as required, to restore original operation. Restoration work to comply with requirements for new work.

3.5 EXISTING MECHANICAL WORK TO BE RELOCATED

- A. General: Disconnect, remove, reinstall and reconnect existing equipment indicated to be relocated and where require to accommodate remodeling or new construction. Extend existing installations as required. Materials and methods used for relocations and extensions to conform to requirements for new work.

3.6 SHUTDOWNS

- A. General: All shutdowns to existing mechanical services to be scheduled and approved, in writing, by the Owner.

3.7 DISPOSITION OF EXISTING MATERIALS AND EQUIPMENT

- A. Items to Salvage: Material and equipment which is indicated (or directed by Owner) to be salvaged, shall be carefully removed and stored where directed on the site.

- B. Items to Reuse/Relocate: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to installation.
- C. Items to Remove: Remove and legally dispose of all other materials and debris resulting from demolition work on a daily basis.

3.8 CLEANING

Remove from the Project Site all dirt, dust and debris resulting from removal operations on a daily basis. Refuse shall not be allowed to block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION 230502

SECTION 230513 - COMMON MOTOR REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.

- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.

- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

END OF SECTION 230513

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SECTION 230515 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFD indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.
 - 1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Enclosure types and details.
 - d. Nameplate legends.
 - e. Short-circuit current (withstand) rating of enclosed unit.
 - f. Features, characteristics, ratings, and factory settings of each VFD and installed devices.
 - g. Specified modifications.
 - 2. Schematic and Connection Wiring Diagrams: Indicate all field wiring required for the project.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
 - 2. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - 4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- 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. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without de-rating, under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
 - 2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F
 - 3. Humidity: Less than 95 percent (non-condensing).
 - 4. Altitude: Not exceeding 3300 feet.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

1.9 COORDINATION

- A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
 - 1. Torque, speed, and horsepower requirements of the load.
 - 2. Ratings and characteristics of supply circuit and required control sequence.
 - 3. Ambient and environmental conditions of installation location.

1.10 WARRANTY

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

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. ABB.
 2. AC Tech/Lenze
 3. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 4. Square D.
- B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- C. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
 - 1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
 - 2. Input AC Voltage Unbalance: Not exceeding 3 percent.
 - 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 - 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
 - 6. Minimum Short-Circuit Current (Withstand) Rating: 22 kA.
 - 7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.
 - 8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
 - 9. Humidity Rating: Less than 95 percent (non-condensing).
 - 10. Altitude Rating: Not exceeding 3300 feet.
 - 11. Vibration Withstand: Comply with IEC 60068-2-6.
 - 12. Overload Capability: 1.15 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 - 13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 - 14. Speed Regulation: Plus or minus 5 percent.
 - 15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 - 16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.
 - 1. Signal: Electrical.

H. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

I. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

J. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

K. Bidirectional Auto Speed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

- L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- N. Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad-lockable, door-mounted handle mechanism.
 - 1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
 - 2. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
 - 3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
 - 4. NC alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Overvoltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - 1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital LCD display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. Set point frequency (Hz).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 0- to 10-V dc or 4- to 20-mA dc
 - b. A minimum of six multifunction programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc or 4- to 20-mA, which can be configured for any of the following:

- a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).
- 4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set point speed reached.
 - c. Fault and warning indication (over temperature or over current).
 - d. PID high- or low-speed limits reached.
- F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.
 - 1. Network Communications Ports: Ethernet and RS-485.
 - 2. Embedded BAS Protocols for Network Communications: Contractor to confirm with Technology Contract and Owner's Representative; protocols accessible via the communications ports.

2.3 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of VFCs to less than 8 percent and THD(V) to 5 percent.
- B. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.
- C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.4 BYPASS SYSTEMS

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
 - 1. Bypass Contactor: Load-break, IEC-rated contactor.
 - 2. Output Isolating Contactor: Non-load-break, IEC-rated contactor.
 - 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
 - 1. NORMAL/BYPASS selector switch.
 - 2. HAND/OFF/AUTO selector switch.
 - 3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
 - 4. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

- b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
- 5. Control Circuits: 24-V ac; obtained from integral CPT, with primary and secondary fuses, with control power source of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 50 VA.
- 6. Overload Relays: NEMA ICS 2.
 - a. Solid-State Overload Relays:
 - 1) Switch or dial selectable for motor-running overload protection.
 - 2) Sensors in each phase.
 - 3) Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - 5) Analog communication module.
 - b. NC/NO isolated overload alarm contact.
 - c. External overload reset push button.

2.5 ENCLOSURES

- A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 4.
 - 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.

- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.6 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.
 - 1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty.
 - a. Push Buttons: Recessed Unguarded types; momentary.
 - b. Pilot Lights: LED types; push to test.
 - c. Selector Switches: Rotary type.
- B. Reversible NC/NO bypass contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Under-voltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable under-voltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

2.7 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.
 - 1. Test each VFD while connected to a motor that is comparable to that for which the VFD is rated.
 - 2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.
- B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HARMONIC ANALYSIS STUDY

- A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels.
- B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

3.3 INSTALLATION

- A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than **79 inches** above finished floor unless otherwise indicated, and by bolting units to wall or mounting on

lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks.

- C. Install fuses in each fusible-switch VFD.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.

3.4 IDENTIFICATION

- A. Identify VFDs, components, and control wiring.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFD with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices and facility's central-control system.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.

2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
 1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- D. Tests and Inspections:
 1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
 3. Test continuity of each circuit.
 4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
 5. Test each motor for proper phase rotation.
 6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 7. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- E. VFDs will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.

3.9 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

END OF SECTION 230515

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SECTION 230529 – SUPPORTS AND SLEEVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Perform all Work required to provide and install supports, hangers, anchors, sleeves and bases for all pipe, duct, equipment, system components and accessories, indicated by the Contract Documents with all supplementary items necessary for complete, code compliant and approved installation

1.2 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - 1. International Mechanical Code.
 - 2. International Plumbing Code.
 - 3. International Fuel Gas Code.
 - 4. ASME B31.2 - Fuel Gas Piping.
 - 5. ASME B31.9 - Building Services Piping.
 - 6. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
 - 7. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 8. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
 - 9. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
 - 10. MSS SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.
 - 11. NFPA 13 - Installation of Sprinkler Systems.
 - 12. NFPA 14 - Installation of Standpipe and Hose Systems.
 - 13. NFPA 99 - Standard for Health Care Facilities.
 - 14. UL 203 - Pipe Hanger Equipment for Fire Protection Service.
 - 15. SMACNA - HVAC Duct Construction Standards.
 - 16. Underwriters Laboratories Standards and Listings.

1.3 QUALITY ASSURANCE

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS-SP-58 and SP-69 unless noted otherwise.

- B. Support and sleeve materials and installation shall not interfere with the proper functioning of equipment.
- C. Contractor shall be responsible for structural integrity of all hangers, supports, anchors, guides, inserts and sleeves. All structural hanging materials shall have a minimum safety factor of five.
- D. Installer Qualifications: Utilize an installer experienced in performing Work of this Section who is experienced in installation of Work similar to that required for this Project and per the minimum requirements of MSS SP-89. Field welding of supports shall be by certified welders qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX using welding procedures per the minimum requirements of MSS SP-58.

1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog data including code compliance, load capacity, and intended application.
- B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.
- C. Shop Drawings: Submit detailed Drawings of all shop or field fabricated supports, anchors and sleeves, signed and sealed by a qualified State of New York registered professional engineer. Indicate size and characteristics of components and fabrication details and all loads exceeding 750 pounds imposed on the base building structure.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Maintain in place until installation.
- C. Store materials protected from exposure to harmful weather conditions.

PART 1 - PRODUCTS

1.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

1.2 MANUFACTURERS

A. Hangers and Supports:

1. Anvil International.
2. Kinder.
3. Cooper B-Line.
4. C & S Mfg. Corp.
5. Hubbard Enterprises/Holdrite
6. National Pipe Hanger Corporation.
7. Power Strut.

1.3 HANGERS AND SUPPORTS

A. General:

1. Refer to individual system and equipment Specification Sections for additional support requirements. Comply with MSS SP-69 for support selections and applications that are not addressed within these Specifications.
2. Utilize hangers and supports to support systems under all conditions of operation, allowing free expansion and contraction, and to prevent excessive stresses from being introduced into the structure, piping or connected equipment.
3. All pipe supports shall be of the type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
4. Design hangers to impede disengagement by movement of supported pipe.
5. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.
6. Wire or perforated strap iron will not be acceptable as hanger material.
7. Hanger rods shall be threaded on both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
8. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation will not be acceptable under any circumstances.
9. Plastic anchors or plastic expansion shields will not be permitted under any circumstances.
10. Hangers and clamps supporting and contacting individual non-insulated brass or copper lines shall be copper or copper plated. Where non-insulated brass or copper lines are supported on trapeze hangers or channels, the pipes shall be isolated from these supports with approved flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp. Plastic tape is not acceptable.

11. Hangers and clamps supporting and contacting glass piping shall be in accordance with the piping manufacturer's published recommendations and shall be fully lined with minimum 1/4 inch neoprene padding. The padding material and the configuration of its installation shall be submitted for approval.
 12. Hangers and clamps supporting and contacting plastic piping shall be in accordance with the piping manufacturer's published recommendations and shall be factory coated or padded to prevent damage to piping.
 13. Field fabricated supports shall be constructed from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- B. Finishes: All ferrous hangers, rods, inserts, clamps, stanchions, and brackets on piping within interior non-corrosive environments, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. All hangers and supports exposed to the weather, including roofs and building crawl space areas, shall be galvanized or manufactured from materials that will not rust or corrode due to moisture. All hangers and supports located within corrosive environments shall be constructed from or coated with materials manufactured for installation within the particular environment.
- C. Vertical Piping:
1. Supports for vertical riser piping in concealed areas shall utilize double bolt riser clamps, with each end having equal bearing on the building structure at each floor level.
 2. Supports for vertical riser piping at floor levels in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the penetrated structure utilizing drilled anchors, two hanger rods (sized as specified), and socket clamp with washers.
 3. Two-hole rigid pipe clamps or four-hole socket clamps with washers may be used to support pipe directly from adequate structural members where floor-to-floor distance exceeds required vertical support spacing and lines are not subject to expansion and contraction.
- D. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on manufactured channel, suspended on rods or pipes. Trapeze members including suspension rods shall be properly sized for the quantity, diameters, and loaded weight of the lines they are to support.
- E. Ductwork: All ductwork shall be supported in accordance with SMACNA recommendations for the service involved. Horizontal ducts supported using galvanized steel bands shall extend up both sides and onto the construction above, where they shall turn over and be secured with bolts and nuts fitted in inserts set in the concrete, bolted to angles secured to the construction above, or secured in another approved manner.
- F. Terminal Units:

1. Terminal units weighing up to 150 pounds shall be supported by four (4) 1 inch wide sheet metal straps with ends turned under bottom of unit at corners.
2. Each band shall be secured by not over 3/4 inch in length, 1/4-inch diameter sheet metal screws – two (2) on bottom of unit and one (1) on each side.
3. The other strap end shall be attached to the structure by 1/4-inch diameter threaded bolt into the concrete insert or into drilled-hole threaded concrete expansion anchor.
4. Where interference occurs, overhead of the box, not allowing direct vertical support by straps, provide trapeze channels suspended by 1/4-inch diameter galvanized threaded rods providing such channels do not block access panels of units.
5. Terminal units weighing more than 150 pounds shall be supported per the terminal unit manufacturer's installation instructions using threaded rod and hanger brackets located per manufacturer's drawing.

G. Fixture and Equipment Service Piping:

1. Piping at local connections to plumbing fixtures and equipment shall be supported to prevent the weight of the piping from being transmitted to fixtures and equipment.
2. Makeshift, field-devised methods of plumbing pipe support, such as with the use of scrap framing materials, are not allowed. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96. These shall be Hubbard Enterprises/Holdrite support systems, C & S Mfg. Corp. or Owner-approved equivalent.
3. Supports within chases and partitions shall be corrosion resistant metal plate, clamps, angles or channels, and aligned with structure in the vertical or horizontal position. Plastic supports are not allowed unless approved by Owner.
4. Horizontal supports within chases and partitions that are attached to studs shall be attached at both ends. Drywall shall not be relied upon to support the piping.
5. Supports for plumbing fixture water service piping within chases and partitions may be attached to cast iron drain and vent pipe with approved brackets and pipe clamps.
6. Piping exposed on the face of drywall shall be supported with corrosion resistant metal channels that are attached to wall studs. Drywall shall not be relied upon to support the piping.
7. Piping supported from the floor shall utilize corrosion resistant metal channels or brackets that are anchored to the floor slab.
8. All water piping shall be isolated from building components to prevent the transmission of sound.
9. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action. Plastic tape is not an acceptable isolation material.

H. Inserts:

1. Cast-in-place concrete inserts shall comply with MSS-SP-69, U.L. and F.M. approved, and sized to suit threaded hanger rods.
 2. Inserts shall have malleable iron case with galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval.
 3. Manufactured inserts for metal deck construction shall have legs custom fit to rest in form valleys.
 4. Shop fabricated inserts shall be submitted and approved by Owner prior to installation.
 5. Inserts shall be of a type that will not interfere with structural reinforcing and that will not displace excessive amounts of structural concrete.
- I. Pipe Shields: Provide pipe shields in accordance with insulation manufacturer's published recommendations. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier.
- J. Concrete Pads and Equipment Bases:
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 2. Construct concrete bases 4 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
 3. Minimum Compressive Strength: 3000 psi at 28 days.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor them into structural concrete substrate.
 6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

1.4 PIPE AND DUCT PENETRATIONS

A. General:

1. Seal penetrations through all rated partitions, walls and floors with U.L. tested assemblies to provide and maintain a rating equal to or greater than the partition, wall or floor.
2. Inside diameter of all sleeves or cored holes shall provide sufficient annular space between outside diameter of pipe, duct or insulation to allow proper installation of required fire and water proofing materials and allow for movement due to expansion and contraction.
3. Exposed ceiling, floor and wall pipe penetrations within finished areas (including exterior wall faces) shall be provided with chrome plated, brass or stamped steel, hinged, split-ring escutcheon with set screw or snap-on type. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings. In exterior, damp, or corrosive environments, use Type 302 stainless steel escutcheons.

B. Floor Pipe Penetrations:

1. Seal penetrations through all floors to provide and maintain a watertight installation.
2. Sleeves cast in the slab for pipe penetrations shall be Schedule 40 steel, ASTM A53, with 2-inch-wide annular fin water-stop continuously welded at midpoint. Entire assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.
3. Cored holes in the slab for pipe penetrations shall be provided with a Schedule 40 steel, ASTM A53, sleeve with 2-inch-wide annular fin water-stop continuously welded at point on sleeve to allow countersinking into slab and waterproofing. Entire sleeve assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.
4. All sleeves shall extend a minimum of two inches above finished floor.
5. Where job conditions prevent the use of a sleeve that extends two inches above the slab, Link-Seal mechanical casing seals manufactured by Thunderline Corporation may be installed to provide a watertight penetration. Mechanical casing seals can be used only for relatively small diameter pipe penetrations. Verify that slab thickness allows proper installation of the link-seal assembly and the required fire stopping prior to applying this exception.

C. Wall Penetrations:

1. Where piping or ductwork passes through non-rated partition, close off space between pipe or duct and construction with gypsum wallboard and repair plaster smoothed and finished to match adjacent wall area.
2. Pipe penetrations through interior rated partitions shall be provided with adjustable prefabricated U.L. listed fire rated galvanized sheet metal sleeves having gauge

thickness as required by wall fire rating, 20-gauge minimum. EXCEPTION: When U.L. Listed assembly does not require a sleeve,

3. Pipe penetrations through exterior walls and walls below grade shall be provided with "Link-Seal" mechanical casing seal manufactured by Thunderline Corporation.
4. Ductwork penetrations through rated partitions, walls and floors shall be provided with sleeves that are manufactured integral with the damper assembly installed.

D. Flashing:

1. Coordinate flashing material and installation required for pipe and duct roof penetrations with Owner and roofing Contractor.
2. Provide flexible flashing and metal counter-flashing where ductwork penetrates exterior walls. Seal penetration water and air tight.
3. Provide acoustical flashing around ducts and pipes penetrating equipment rooms, with materials and installation in accordance with manufacturer's instructions for sound control.

E. Roof Curbs: Coordinate roof curb material and installation with Owner and roofing Contractor.

PART 2 - EXECUTION

2.1 PREPARATION

- A. Conduct a pre-installation meeting prior to commencing Work of this Section to verify Project requirements, coordinate with other trades, establish condition and completeness of substrate, review manufacturer's installation instructions and manufacturer's warranty requirements.

2.2 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. Application, sizing and installation of piping, supports, anchors and sleeves shall be in accordance with manufacturer's printed installation instructions.
- C. Provide for vertical adjustments after erection and during commissioning, where feasible, to ensure pipe is at design elevation and slope.
- D. Install hangers and supports to allow controlled thermal movement of piping systems, permitting freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

- E. Install hanger so that rod is vertical under operating conditions.
- F. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.
- G. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete that holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required. Contractor shall be responsible for engaging a structural engineer as required for design and review at support systems.
- H. Do not hang pipe, duct or any mechanical/plumbing item directly from a metal deck or locate on the bottom chord of any truss or joist unless approved by the Structural Engineer of Record.
- I. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc.
- J. Piping supports shall be independent from ductwork supports. Combining supports is not permitted.
- K. Provide all supporting steel required for the installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the Drawings.
- L. All piping and ductwork supports shall be designed and installed to allow the insulation to be continuous through the hangers.
- M. Adjustable clevis hangers shall be supported at rods with a nut above and below the hanger.
- N. All hanger rods shall be trimmed neatly so that 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the Contractor shall take appropriate measures to protect the pipe or other materials from damage.
- O. Install hangers to provide minimum ½ inch space between finished covering and adjacent structures, materials, etc.
- P. Horizontal and vertical piping in chases and partitions shall be supported to prevent movement and isolated from the supports to prevent transmission of sound.
- Q. Locate hangers within 12 inches of each horizontal elbow.
- R. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

- S. Support riser piping independently of connected horizontal piping. Riser piping is defined as vertical piping extending through more than one floor level.
- T. Support riser piping at each floor level and provide additional supports where floor-to-floor distance exceeds required vertical support spacing. Installation of riser clamps and welded steel riser supports shall not allow weight of piping to be transmitted to floor sleeves.
- U. Steel Bar Joists: Hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded or otherwise permanently fixed to the top of joists.
- V. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.
- W. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. attached to the precast, double tee, structural concrete system shall be installed in accordance with approved Shop Drawings only. Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4 inch larger than the diameter of the hanger rod. Hanger rods shall supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15 inches of each stem and in the "shadow" of the stem on the top side of the "double tees".
- X. 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.
- Y. Inserts:
 - 1. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 2. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 3. Install anchors in concrete after concrete is placed and completely cured. Install anchors according to manufacturer's written instructions..
- Z. Flashing:
 - 1. Coordinate all roof flashing with requirements of Division 07.
- AA. Pipe Shields:

1. Provide shields at each hanger supporting insulated pipe.
2. Provide shields of the proper length to distribute weight evenly and to prevent compression of insulation at hanger.
3. Install shield so that hanger is located at the center of the shield.
4. Attach shield to insulation with adhesive to prevent slippage or movement.

BB. Equipment Anchor Bolts:

1. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of sufficient size to provide ½ inch clearance around bolt.

END OF SECTION 230529

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SECTION 230553 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Duct labels.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.3 COORDINATION

- A. Coordinate installation of identifying devices with locations of access panels and doors.
- B. Install identifying devices before ceilings are installed.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Stainless steel, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel self-tapping screws.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: White.
 3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment designation or tag number and service. Provide additional information where indicated or requested by Owner/Engineer.
- D. Equipment Label Schedule: Include schedule in IOM manual.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Length: 12" for piping less than or equal to 4" NPS, 24" for piping greater than 4" NPS.
 3. Lettering Size: 1.25" for piping less than or equal to 4" NPS, 24" for piping greater than 4" NPS.
- D. Pipe Label Color Schedule:
1. Chilled-Water Piping: Blue background with white lettering.
 2. Condenser-Water Piping: Green background with white lettering.
 3. Heating Hot Water Piping: Yellow background with black lettering.

2.3 DUCT LABELS

- A. Stencils: Minimum letter height of 3 inches.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel, black unless otherwise indicated. Paint may be in pressurized spray-can form.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 DUCT LABEL INSTALLATION

- A. Stenciled labels, showing service and flow direction, increase lettering size where needed for proper identification because of distance from normal location of required identification.

- B. Locate labels in mechanical equipment rooms near points where ducts penetrate walls or enter into concealed spaces and at maximum intervals of 20 feet or as required to properly identify ductwork.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

- A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB field supervisor meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 15 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
- B. TAB Conference: Meet with Engineer on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide 14 days' advance notice of scheduled meeting time and location.

1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
 - C. Certify TAB field data reports and perform the following:
 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
 - D. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.
 - E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
 - F. Upon request by Engineer, submit instrument calibration reports, to include the following:
 1. Instrument type and make.
 2. Serial number.
 3. Application.
 4. Dates of use.
 5. Dates of calibration.
- 1.5 PROJECT CONDITIONS
- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
 - B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- 1.6 COORDINATION
- A. Notice: Provide 14 days advance notice for each test. Include scheduled test dates and times.
 - B. Perform TAB after all specified leakage and pressure tests on have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- E. Examine test reports specified in individual system and equipment Sections.
- F. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- G. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- H. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- I. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- K. Examine system pumps to ensure absence of entrained air in the suction piping.
- L. Examine operating safety interlocks and controls on HVAC equipment.
- M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance, smoke, and fire dampers are open.
5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
6. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- 3.6 PROCEDURES FOR DUCT SILENCERS
- A. Adjust fans to deliver total indicated airflow for each silencer.
1. Measure total airflow.

- a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
2. Measure differential static pressure.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 8. Record final fan-performance data.

3.8 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.9 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, airflow, and static pressure of each fan.
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the refrigerant charge.
 - 4. Check the condition of filters.
 - 5. Check the condition of coils.
 - 6. Check the operation of the drain pan and condensate-drain trap.
 - 7. Check bearings and other lubricated parts for proper lubrication.
 - 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
 - 1. New filters are installed.
 - 2. Coils are clean and fins combed.
 - 3. Drain pans are clean.
 - 4. Fans are clean.
 - 5. Bearings and other parts are properly lubricated.
 - 6. Deficiencies noted in the preconstruction report are corrected.

- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 - 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 - 3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 - 4. Balance each air outlet.

3.10 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.

3.11 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.12 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.

- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.

- f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 2. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.

- j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h.
- G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- H. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
- 1. Report Data:
 - a. System and air-handling-unit number.

- b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- I. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- J. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.

- d. Dates of use.
- e. Dates of calibration.

3.13 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by the Engineer.
2. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
3. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
4. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

- D. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following interior ductwork.
 - 1. Supply and return air ductwork (except where noted).
 - 2. Outdoor air ductwork.
 - 3. Exhaust air ductwork (3 feet from penetration of building exterior).
 - 4. Exterior ductwork.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Include insulation schedule indicating applications and methods of compliance with specified performance.

1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 COORDINATION

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

1.5 DEFINITIONS

- A. Concealed: Located above ceilings or in chases, shafts or soffits.

- B. Exposed: Where visible when construction and finishes are complete including mechanical rooms, storage areas, and spaces without ceilings.

1.6 SCHEDULING

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

PART 2 - PRODUCTS

2.1 DUCT AND PLENUM INSULATION SCHEDULE

- A. Supply and return air ductwork.
 - 1. Concealed Locations: Mineral-Fiber Blanket; R-6.
 - 2. Exposed Locations: Mineral-Fiber Board; R-6.
 - 3. Exception: Supply and return air ductwork exposed to view in conditioned spaces served by ductwork shall not be insulated.
- B. Outdoor air ductwork and plenums.
 - 1. Concealed Locations: Mineral-Fiber Blanket; R-12
 - 2. Exposed Locations: Mineral-Fiber Board; R-12
- C. Exhaust air ductwork and plenums (3 feet from penetration of building exterior or isolation damper, whichever is longer).
 - 1. Concealed Locations: Mineral-Fiber Blanket; R-12
 - 2. Exposed Locations: Mineral-Fiber Board; R-12
- D. Exterior ductwork.
 - 1. Mineral-Fiber Board with Field Applied Jacketing; R-12.
- E. Items Not Insulated:
 - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums and casings.
 - 4. Flexible connectors.
 - 5. Vibration-control devices.
 - 6. Factory-insulated access panels and doors.

2.2 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following. No substitutions will be permitted without written approval prior to receipt of bids:
 - 1. CertainTeed Corp.
 - 2. Johns Manville.
 - 3. Knauf Insulation.
 - 4. Manson Insulation Products Ltd.
- C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553.
 - 1. FSK Jacket: Factory applied aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 - 2. Provide density and thickness as required to meet R-Values specified in the Insulation Schedule. R-Values shall be Installed at 25% compression.
- D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB, with factory-applied FSK jacket.
 - 1. FSK Jacket: Factory applied aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 - 2. Provide density and thickness as required to meet R-Values specified in the Insulation Schedule.

2.3 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 - 2. Width: 3 inches.
 - 3. Thickness: 6.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire resistant lagging cloths over duct insulation.
 4. Service Temperature Range: 0 to 180 deg F.
 5. Color: White.

2.5 FIELD-APPLIED JACKETS

- A. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco embossed aluminum-foil facing.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Polyguard Products, Inc.; Alumaguard 60.
 - b. VentureCladPlus 1579GCW-E

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install 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.
- C. Keep insulation materials dry during application and finishing.
- D. Install insulation with least number of joints practical.
- E. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

3.4 PENETRATIONS

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

END OF SECTION 230713

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SECTION 230800 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The requirements of this section are supplementary to the General Commissioning Requirements for the project and do not negate or supersede the commissioning requirements specified elsewhere.
- B. This section defines the commissioning responsibilities of the Division 23 Contractor (referred to herein as either "MC" or "the Contractor") and all other subcontractors or factory-authorized service representatives responsible for the systems to be commissioned. The responsibilities of other parties, including the Commissioning Agent (CxA), Owner, and Design Team (A/E) are referenced for clarification purposes only.
- C. This section includes additional commissioning process requirements for the following HVAC systems, assemblies and equipment. This list of Systems to be Commissioned may be modified as described in 019113 "General Commissioning Requirements." The final list of Systems to be Commissioned will be included in the Commissioning Plan provided by the CxA.
 - 1. Building Automation and Temperature Control Systems.
 - 2. Packaged Rooftop Heating and Cooling Units.
- D. Related Requirements:
 - 1. Section 019113 "General Commissioning Requirements" describes the overall commissioning process and responsibilities for which this contract is responsible.
- E. Abbreviations: The following are common abbreviations used in the Specifications. For additional definitions refer to Section 019113.
 - 1. A/E: Architects and Engineers
 - 2. Cx: Commissioning
 - 3. CxA: Commissioning Authority
 - 4. Cx Plan: Commissioning Plan Document
 - 5. CC: Controls Contractor
 - 6. CM: Construction Manager
 - 7. EC: Electrical Contractor
 - 8. FT: Functional Performance Test
 - 9. MC: Mechanical Contractor
 - 10. PFI: Pre-Functional Inspection
 - 11. TAB: Test and Balance Contractor

1.2 INFORMATIONAL SUBMITTALS

A. Prefunctional Checklists

1. Submit according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.

B. Startup and Manufacturer Test Reports

1. Obtain copies of all startup reports as well as any test reports prepared by factory authorized service representatives as required by the specification section for each commissioned system. Promptly provide copies of reports to the CxA, as requested.

C. Requests for Clarification

1. The CxA may request supplemental written clarification for items which are not clearly indicated in equipment submittal documentation. Where such requests are made, the MC shall provide written responses to the CxA within 5 business days. Examples of such requests may include, but are not limited to, clarification of equipment operating sequences, performance data, startup requirements, selected options or accessories, etc.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 MEETINGS

- A. Attend commissioning meetings as described in the General Commissioning Requirements.
- B. Commissioning meetings may be scheduled separately from regular construction progress meetings, at the discretion of the CM and CxA.

3.2 COORDINATION AND SCHEDULING

- A. MC shall coordinate schedule for prefunctional checklists and equipment startup with CxA.
- B. CxA shall review and approve prefunctional checklists and equipment startup reports prior to scheduling functional testing.

3.3 PREFUNCTIONAL CHECKLISTS

- A. Blank copies of the required checklists will be provided by the CxA for use by the MC.
- B. Completed copies of checklists shall be submitted to the CxA according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.
- C. Where checklists require sign-off by multiple parties (e.g. checking of electrical connections by the EC on equipment provided by the MC) each party shall complete their respective portions of the checklist and shall organize all documentation into a single, comprehensive checklist record. Responsible parties shall be indicated by the CxA on each checklist.
- D. The MC shall submit any requests for direction on completion of checklists in writing to the CM and CxA.

3.4 FUNCTIONAL PERFORMANCE TESTING

- A. The objective of functional performance testing is to demonstrate that each commissioned system is installed and operating in accordance with the documented design intent. Functional testing shall commence only after all prefunctional inspections, manufacturer testing and startup activities are complete.
- B. The detailed functional testing requirements for each commissioned system will be established in the Commissioning Plan and the Functional Testing Procedures to be developed by the CxA.
- C. Before test procedures are written, the CxA shall obtain all requested documentation related to the intended functional performance of the commissioned systems. This includes submittal documentation, change orders, requests for information, design clarifications, and updated controls system programming information (points lists, control sequences, etc).
- D. MC shall provide assistance to the CxA by reviewing the procedures and responding to questions and concerns posed by the CxA.
- E. General testing requirements:
 - 1. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating in accordance with the Contract Documents and approved Shop Drawings and submittals.
 - 2. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and

approved Shop Drawings and submittals, and that pretest set points have been recorded.

3. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
4. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.
5. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response in accordance with commissioning and acceptance test criteria.

3.5 SEASONAL TESTING

- A. Where seasonal tests are specified, scheduled, or otherwise required by the CxA, the MC shall provide qualified personnel to assist with execution of tests. Where required, the MC shall also secure the services of factory-authorized personnel who are fully capable of executing the required tests.

3.6 MANUFACTURER'S FIELD SERVICE

- A. Where required in these specifications, the MC shall retain the services of a factory-authorized representative, vendor's representative, or third-party testing service to carry out equipment startup and testing services (hereby referred to as "Manufacturer's Field Service").
- B. The MC shall ensure that the contract for Manufacturer's Field Service contains sufficient time, in addition to normal startup activities, for the representative to assist the commissioning team in completing functional performance tests. The scope and schedule of testing will be directed by the CxA. This requirement applies to service contracts for each of the commissioned system identified in these specifications.
- C. It shall be the responsibility of the Contractor to specifically request and secure all Manufacturer's Field Services necessary for the startup and commissioning activities specified in the contract documents. Where the standard Manufacturer's Field Service proposed by a vendor or third party service representative may otherwise be insufficient, the necessary services shall be secured during the equipment procurement process.
- D. Following correction of deficiencies, the MC shall arrange for Manufacturer's Field Service required to re-test previously deficient systems, as directed by the CxA.

3.7 DEFICIENCIES, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. MC shall be responsible for responding to deficiencies or items of non-conformance related to the system.
- B. Where deficiencies are identified during the commissioning process, the MC shall issue a written response.
- C. Deficiencies shall be corrected in a timely manner. Once corrections are made, notify the CxA that the system(s) are ready for re-inspection and/or re-testing.
- D. Items which are not corrected, require multiple inspections by the CxA to resolve, or which result in scheduling delays may result in back charges to the responsible party. Refer to the section entitled "Documentation, Non-Conformance and Approval of Tests" in section 019113 for additional information on deficiency resolution.
- E. Upon successful completion of testing for each system, the CxA will document the results of testing in the functional testing record. A copy of the test record shall be included in the commissioning documentation to be provided to the Owner upon completion of commissioning.

3.8 OWNER TRAINING

- A. Training shall be provided by the MC in coordination with the Owner, CM and CxA. Adequacy of training shall be verified by the CxA, though the CxA may opt not attend all portions of training. For detailed training requirements, refer to section 019113 "General Commissioning Requirements" as well as the requirements contained within the individual equipment specifications.

3.9 PERSONNEL

- A. Provide qualified technicians, instrumentation, tools and equipment during the startup, functional testing, and seasonal testing of the commissioned systems. Ensure the availability of at least one individual on site during commissioning tests.

END OF SECTION 230800

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SECTION 230900 - BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 OVERVIEW

- A. HVAC controls shall be furnished and installed by the Owner. All hardware, wiring and programming to be provided by Owner. Mechanical Contractor is responsible for coordinating with the Owner's vendor throughout the project to support installation, testing and commissioning. Mechanical Contractor to install all devices mounted in or on the piping and/or ductwork including but not limited to hydronic control valves, temperature sensors, flow sensors, etc. Mechanical Contractor to provide all necessary ports/thermowells for sensors, gauges, etc. Coordinate with Owner's vendor for quantity and locations.
- B. Owner shall expand existing building automation system (BAS) at each building to provide the control sequences specified on drawings. The system shall provide control and monitoring of the equipment indicated.
- C. Owner shall provide controllers and communications infrastructure to match existing BAS in each building. Provide seamless integration with existing control network and user interfaces. Network gateways and protocol interface equipment are not acceptable.

1. Contact Information:

Scott Sullivan
Account Executive
Day Automation
518-729-6919
scott.sullivan@dayautomation.com

- D. Owner shall provide instrumentation, valves, dampers, actuators and wiring as required to provide specified operating sequences.
- E. Owner shall modify existing graphical user interfaces and/or provide new graphical user interfaces to include all equipment/systems included in this project.

1.2 SCOPE OF WORK

- A. The Owner shall furnish and install all necessary software and hardware, wiring, and computing equipment in compliance with this specification. Any variances from this specification or related documentation shall be submitted in writing at the time of bid.
- B. System Requirements

1. Standard Material/Products. All material and equipment used shall be standard components, regularly manufactured and available, and not custom designed especially for this project
2. Modular Design. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.
3. Performance. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.
4. Equipment: The Contractor shall provide the following system hardware:
 - a. All sensing devices, relays, switches, indicating devices, and transducers required to perform the functions as listed in I/O Summary Tables.
 - b. All monitoring and control wiring.

1.3 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
 1. National Electric Code (NEC)
 2. New York State Building Codes
 3. ANSI/ASHRAE 135-2004: Data Communication Protocol for Building Automation and Control Systems (BACnet)
- B. Conflict of Codes. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.

1.4 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards.
 1. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
 2. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
 3. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

Table 1 - Reporting Accuracy

Measured Variable	Reported Accuracy
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Space Temperature	±0.5°C (±1°F)
Ducted Air	±0.5°C (±1°F)
Outside Air	±1.0°C (±2°F)
Dew Point	±1.5°C (±3°F)
Water Temperature	±0.5°C (±1°F)
Delta-T	±0.15°C (±0.25°F)
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm

Note 1: Accuracy applies to 10% - 100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

Table 2 - Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±3°F)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1-150 psi) 0-12.5 kPa (0-50 in. w.g.) differential

1.5 SUBMITTALS, DOCUMENTATION, ACCEPTANCE AND TRAINING

A. Submittals:

1. Shop Drawings. Include a complete list of equipment, materials, manufacturer's technical literature, cut-sheets, and installation instructions. Drawings shall contain

proposed layout, complete wiring, routing, schematic diagrams, tag number of devices, software descriptions, calculations, installation details, and any other details required to demonstrate that the system will function properly.

2. Graphical Programming Documentation: The Contractor shall submit for approval, all proposed graphic displays in full color hard copy and an electronic copy in HTML format viewable on any web browser for all Graphical Displays, identifying the specific subsystem being controlled. Provide no later than 45 calendar days after contract award.
3. As Built Drawings. All drawings shall be reviewed after the final system checkout and updated or corrected to provide 'as-built' drawings to show exact installation. All shop drawings will be acknowledged in writing by Architect/Engineer before installation is started and again after the final checkout of the system. The system will not be considered complete until the 'as-built' drawings have received their final approval. The Contractor shall as-built drawings in electronic format as PDF documents.

B. Documentation:

1. Operating and Maintenance (O&M) manuals for the system shall be made available electronically (PDF) and include the following categories: Project Engineering Handbook, Software Documentation.
2. Project Engineering Manual shall contain as a minimum:
 - a. System architecture overview
 - b. Hardware cut-sheets and product descriptions.
 - c. The Contractor shall deliver six (6) sets of 'as-built' drawings. All drawings shall be reviewed after the final system checkout and updated to provide 'as-built' drawings. The system will not be considered complete until the 'as-built' drawings have received their final approval.
 - d. Installation, mounting and connection details for all field hardware and accessories
 - e. Commissioning, setup and backup procedures for all control modules/accessories, BAS server software, and database.
 - f. Listing of basic terminology, alarms/messages, error messages and frequently used commands or shortcuts.
 - g. Operator training 'video' submitted on CD or DVD format.
3. Acceptance Test
 - a. Acceptance Testing. Upon completion of the installation, the Contractor shall start up the system and perform all necessary calibration, testing, and debugging operations. The Contractor in the presence of the Owner's representative shall perform an acceptance test.
 - b. Notice of Completion. When the system performance is deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty.

At this time, Architect/Engineer shall issue a "notice of substantial completion" and the warranty period shall start.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

- A. Install new wiring and network devices as required to provide a complete and workable control network.

2.3 FIELD HARDWARE/INSTRUMENTATION

A. Temperature Sensing Devices

1. Type & Accuracy. Temperature sensors shall be of the type and accuracy indicated for the application. Sensors shall have an accuracy rating within 1% of the intended use temperature range.
2. Outside Air Temperature Sensors. Outside air temperature sensors' accuracy shall be within +1°F in the range of -52°F to 152°F.
3. Room Temperature Sensors. Room temperature sensors shall have an accuracy of +0.36°F in the range of 32°F to 96°F.
4. Chilled Water and Condenser Water Sensors. Chilled water and condenser water sensors shall have an accuracy of +0.25°F in their range of application.
5. Hot Water Temperature Sensors. Hot water temperature sensors shall have an accuracy of +0.75°F over the range of their application.

B. Pressure Instruments

1. Differential Pressure and Pressure Sensors: Sensors shall have a 4-20 MA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated pressure, without damaging the device. Accuracy shall be within +2% of full scale. Sensors shall be manufactured by Leeds & Northrup, Setra, Robertshaw, Dwyer Instruments, Rosemont, or be approved equal.
2. Pressure Switches: Pressure switches shall have a repetitive accuracy of +2% of range and withstand up to 150% of rated pressure. Sensors shall be diaphragm or bourdon tube design. Switch operation shall be adjustable over the operating pressure range.

The switch shall have an application rated Form C, snap-acting, self-wiping contact of platinum alloy, silver alloy, or gold plating.

C. Flow Switches:

1. Flow switches shall have a repetitive accuracy of +1% of their operating range. Switch actuation shall be adjustable over the operating flow range. Switches shall have snap-acting Form C contacts rated for the specific electrical application.

D. Humidity Sensors:

1. Sensors shall have an accuracy of +2.5% over a range of 20% to 95% RH.

E. Current Sensing Relays

1. Relays shall monitor status of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for the application. The setpoint of the contact operation shall be field adjustable.

F. Output Relays

1. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting Form C contacts, enclosed in dustproof enclosure. Relays shall have silver cadmium contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression devices.

G. Solid State Relays

1. Input/output isolation shall be greater than 10 billion ohms with a breakdown voltage of 15 V root mean square, or greater, at 60 Hz. The contact operating life shall be 10 million operations or greater. The ambient temperature range of SSRs shall be 20° F-140° F. Input impedance shall be greater than 500 ohms. Relays shall be rated for the application. Operating and release time shall be 10 milliseconds or less. Transient suppression shall be provided as an integral part of the relays.

H. Valve and Damper Actuators

1. Electronic Direct-Coupled: Electronic direct-coupled actuation shall be provided.
2. Actuator Mounting: The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a 'V' bolt design with associated 'V' shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a 'V' clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable

3. Electronic Overload Sensing: The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
 4. Power Failure/Safety Applications: For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
 5. Spring Return Actuators: All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
 6. Proportional Actuators: Proportional actuators shall accept a 0 to 10VDC or 0 to 20mA control input and provide a 2 to 10VDC or 4 to 20mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10VDC position feedback signal.
 7. 24 Volts (AC/DC) actuators: All 24VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC shall not require more than 11VA.
 8. Non-Spring Return Actuators: All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque shall have a manual crank for this purpose.
 9. Modulating Actuators: All modulating actuators shall have an external, built-in switch to allow reversing direction of rotation.
 10. Conduit Fitting & Pre-Wiring: Actuators shall be provided with a conduit fitting and a minimum 3ft electrical cable, and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
 11. U.L. Listing: Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
 12. Warranty: Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.
- I. Control Valves: Provide factory fabricated U.S. forged and assembled electric control valves of type, body material, and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Except as otherwise indicated, provide valves which mate and match material of connecting piping. Equip control valves with control valve motor actuators, with proper shutoff rating for each individual application.

1. Water Service Valves: Equal percentage characteristics with rangeability of 50 to 1, Class 150 at 250°F and maximum full flow pressure drop 5 psig. Globe type with replaceable plugs and seats of stainless steel or brass. Select operators to close valves against pump shutoff head.
 2. Double Seated Valves: Balanced plug type, with caged type trim providing seating and guiding surfaces on "top and bottom" guided plugs.
 3. Valve Trim and Stems: Polished stainless steel.
 4. Packing: Spring-loaded teflon, self-adjusting.
 5. Terminal Unit Control Valves: Provide control ball valves for control of terminal units including, but not necessarily limited to, convectors, thinned tube radiation, and fan coil - units that are of integral motor type. Provide 2-position or modulating type valves, electrically actuated by line voltage or by 24VAC.
- J. Dampers: Provide automatic control low leakage, opposed blade dampers, with damper frames not less than formed 13-gauged galvanized steel. Provide mounting holes for enclosed duct mounting. Provide damper blades not less than formed 16-gauged galvanized steel, with maximum blade width of 8-inch. Equip dampers with motors of proper rating of each application.
1. Secure blades to ½ inch diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings Nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristics plus size schedule for controlled dampers.
 2. Operating Temperature Range: From -20° to 200°F (-29° to 93°C).
 3. For low leakage application or opposed blade design (as selected by manufacturers sizing techniques) with inflatable steel blade edging or replaceable rubber seals, rated for leakage less than 10 cfm per square foot of damper area, AR differential pressure of 4-inch w.g. when damper is being held by torque 50 inch-pounds.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Provide power from existing electrical distribution system as necessary for control system. Comply with the National Electrical Code.

3.2 INSTALLATION

- A. Connect and configure equipment and software to achieve sequence of operation specified.

- B. Verify location of exposed control sensors with architect prior to installation. Install devices 60 inches above the floor.
- C. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

3.3 ELECTRICAL WIRING SCOPE

- A. This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor. If power circuits are shown on the electrical drawings, this contractor shall continue the power run to the control device. If power circuits are not shown, this contractor shall coordinate with the electrical contractor to provide breakers at distribution panels for power to controls. This contractor is then responsible for power from the distribution panel.
 - 1. Coordinate panel locations. If enclosures for panels are shown on the electrical drawings, furnish the enclosures according to the electrician's installation schedule.
- B. This contractor shall not be responsible for power to control panels and control devices that are furnished by others, unless it is part of the control interlock wiring.
- C. Refer to Coordination section for what devices this contractor is responsible to mount and which are turned over to others to mount.
- D. This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.
- E. Wiring for controls furnished by others:
 - 1. Provide control wiring for HVAC controls furnished by others. Wiring may include, but not limited to, the following items:
 - a. Thermostats
 - b. Condensers
 - c. Chiller control devices shipped loose
 - d. Leak detectors
 - e. Humidifier controls
 - f. Refrigerant leak monitoring systems
 - g. Exhaust or Purge fans
 - h. Manual switches for HVAC equipment (not shown on electrical drawings)
 - i. Emergency ventilation switches (not shown on electrical drawings)
 - j. Emergency shutdown switches (not shown on electrical drawings)
 - 2. Provide control wiring for the following non-HVAC controls furnished by others if they are called for in this project:

- a. Electrical vault fans
 - b. Emergency generator dampers
 - c. Water treatment
 - d. Interlock to fire suppression system
 - e. Leak detection system
 - f. Fuel oil monitoring system
 - g. Fuel oil fill system
- F. Interlock wiring shall be run in separate conduits from BAS associated wiring.
- G. Provide network wiring for equipment that is called to be integrated to the BAS.

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."
- B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Section 271500 "Communications Horizontal Cabling."
- 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 4. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 5. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 6. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual reset limit controls independent of manual control switch positions.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.5 COMMUNICATION WIRING

- A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

- B. Do not install communication wiring in raceway and enclosures containing Class 1 wiring.
- C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- D. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
- E. Cable bundling:
 - 1. RS485 cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.
 - 2. RS485 cabling run between terminal units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other class 2 low voltage cabling.
 - 3. RS485 cabling run between floors shall be in a communication only conduit.
 - 4. RS485 conduit run long distances between utility rooms or between buildings shall be in a communication only conduit.
 - 5. Ethernet cabling shall be in a communication only conduit.
 - 6. Ethernet and RS485 can be run together.
 - 7. Fiber optics can be run with Ethernet and RS485 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.
- F. FLN or BACnet BACnet MS/TP Cabling
 - 1. RS485 cabling shall be used for BACnet MS/TP networks.
 - 2. RS485 shall use low capacitance, 20-24 gauge, twisted shielded pair.
 - 3. The shields shall be tied together at each device.
 - 4. The shield shall be grounded at one end only and capped at the other end.
 - 5. Provide end of line (EOL) termination devices at each end of the RS485 network or subnetwork run, to match the impedance of the cable, 100 to 120ohm.
- G. Ethernet Cabling
 - 1. Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
 - 2. CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
 - 3. Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50 feet away.
 - 4. When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.
- H. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.
- I. All runs of communication wiring shall be unspliced length when that length is commercially available.

- J. All communication wiring shall be labeled to indicate origination and destination data.
- K. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 5. Test each system for compliance with sequence of operation.
 - 6. Test software and hardware interlocks.
- C. DDC Verification:
 - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 - 2. Check instruments for proper location and accessibility.
 - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 - 4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 - 5. Check control valves. Verify that they are in correct direction.
 - 6. Check DDC system as follows:
 - a. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - b. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.7 SYSTEM COMMISSIONING, DEMONSTRATION AND TURNOVER

- A. The BAS Contractor shall prepare and submit for approval a complete acceptance test procedure including submittal data relevant to point index, functions, sequence, interlocks, and associated parameters, and other pertinent information for the operating system. Prior to acceptance of the BAS by the Owner and Engineer, the BAS contractor shall completely test the BAS using the approved test procedure.
- B. After the BAS contractor has completed the tests and certified the BAS is 100% complete, the Engineer shall be requested, in writing, to approve the satisfactory operation of the system, sub-systems and accessories. The BAS contractor shall submit Maintenance and Operating manuals at this time for approval. An acceptance test in the presence of the Engineer and Owner's representative shall be performed. The Owner will then shake down the system for a fixed period of time (30 days).
- C. The BAS contractor shall fix punch list items within 30 days of acceptance.
- D. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

3.8 PROJECT RECORD DOCUMENTS

- A. Project Record Documents: Submit three (3) copies of record (as-built) documents upon completion of installation. Submittal shall consist of:
 - 1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11 x 17 inch prints.
 - 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.
 - 3. Operation and Maintenance (O & M) Manual.
 - a. As-built versions of the submittal product data.
 - b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
 - c. Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - d. Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how

- to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - f. Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.
 - g. Graphic files, programs, and database on electronic media.
 - h. List of recommended spare parts with part numbers and suppliers.
 - i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
 - j. Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
 - k. Licenses, guarantees, and warranty documents for equipment and systems.
- B. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:
- 1. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.
 - 2. Description of manual override operation of all control points in system.
 - 3. BMS system manufacturers complete operating manuals.
- C. Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:
- 1. Complete as-built installation drawings for each building system.
 - 2. Overall system electrical power supply schematic indicating source of electrical power for each system component. Indicate all battery backup provisions.
 - 3. Photographs and/or drawings showing installation details and locations of equipment.
 - 4. Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.
 - 5. Parts list with manufacturer's catalog numbers and ordering information.
 - 6. Lists of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.
 - 7. Manufacturer's operation, set-up, maintenance and catalog literature for each piece of equipment.
 - 8. Maintenance and repair instructions.
 - 9. Recommended spare parts.
- D. Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:
- 1. Complete programming manuals, and reference guides.
 - 2. Details of any custom software packages and compilers supplied with system.

3. Information and access required for independent programming of system.

3.9 TRAINING

- A. During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware and accessories.
- B. At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give 16-hours of onsite training on the operation of all BAS equipment. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:
 1. Explanation of drawings and operator's maintenance manuals.
 2. Walk-through of the job to locate all control components.
 3. Operator workstation and peripherals.
 4. DDC Controller and ASC operation/sequence.
 5. Operator control functions including scheduling, alarming, and trending.
 6. Explanation of adjustment, calibration and replacement procedures.
- C. Additional 8-hours of training shall be given after the 30 day shakedown period.
- D. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer's standard pricing such as transportation, meals, etc.

END OF SECTION 230900

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SECTION 230993 - SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes building automation monitoring and operating sequences for building systems and equipment as described herein.
- B. This Section includes operating sequences for various pieces of new equipment in multiple buildings. All new equipment shall be connected to the existing Building Automation System in each respective building and configured as described below. The Contractor is responsible to field verify the existing control system at each building and provide all hardware, control wiring, electrical wiring, programming and graphics to provide a complete installation.

1.2 DEFINITIONS

ADJ	Operator Adjustable
AI	Analog input.
AO	Analog Output.
DDC	Direct digital control.
DI	Digital input.
DO	Digital output.
EAT	Entering air temperature.
EWT	Entering water (fluid) temperature.
LAT	Leaving air temperature.
LWT	Leaving water (fluid) temperature.
OA	Outdoor air.
OAF	Outdoor Airflow (cfm)
OAT	Outdoor air temperature
VFD	Variable frequency drive.
WP	Water proof/weather resistant.

1.3 ACTION SUBMITTALS

A. Product Data:

1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

B. Shop Drawings:

1. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 GENERAL:

- A. Setpoints and schedules described in the operation of building systems shall be operator adjustable unless otherwise indicated.
- B. Unless otherwise noted the space temperature setpoints for each system shall be as follows:

<u>Operating Mode</u>	<u>Space Temperature Setpoint</u>
Occupied Heating	70°F
Occupied Cooling	75°F
Unoccupied Heating	60°F
Unoccupied Cooling	85°F

- C. Provide digital input from fire alarm system to indicate activation of system. Coordinate interface with the EC.

3.2 DEDICATED OUTDOOR AIR SYSTEM (DOAS-1/2/3/4)

A. Main System Components

1. Outside air motorized damper, modulating type, normally closed.
2. Return air motorized damper, modulating type, normally open.
3. Exhaust air motorized damper, modulating type, normally closed.
4. Gas heat, modulating type, normally off.
5. Supply fan VFD, 0% speed output.
6. Exhaust fan, VFD, 0% speed output.
7. Energy recovery wheel.

B. Hardwired Safeties

1. Safeties shall be enabled at all time.
2. The area smoke detectors or factory mounted duct smoke detectors shall shutdown the supply fan on a smoke condition through the Fire Alarm System (FAS). The unit shutdown wiring from FAS output module to unit shutdown circuit shall be provided and installed by fire alarm contractor. FAS shall notify BAS to restore normal controls upon deactivation of fire alarm condition.
3. BAS shall shutdown the supply fan upon abnormal current detected by VFD and raise critical alarm.

C. System Off

1. When the system is off, all dampers and controlled devices shall be in their normal position.

D. System Start-Up

1. The system shall run via optimum start program, occupancy schedule, space occupancy switches (integral with space temperature sensor) or controlled manually via the operator's workstation.
2. On start-up the system shall be indexed to temperature control mode.
3. Fans shall be enabled only upon confirmation of associated damper opening via end switch.

- E. Morning Warm-up Mode: The unit fan shall start, the mixed air dampers shall be set to 100% return air position, and the unit shall operate in heating mode. Exhaust fan shall be

off during warm-up mode. When space temperature reaches occupied setpoint, the system shall switch to occupied mode operation.

1. Provide optimal start algorithm for morning warm-up mode to minimize time of this operation while achieving comfort conditions by the start of the scheduled occupied period.
- F. Morning Cool-down Mode: The unit fan shall start, the OA/EA dampers shall be set to 100% open, and the unit shall operate in economizer mode with the bypass damper open and the energy wheel off if ambient conditions are acceptable. Exhaust fan shall be on during cool-down mode. When space temperature reaches occupied setpoint, the system shall switch to occupied mode operation.
1. Provide optimal start algorithm for morning cool-down mode to minimize time of this operation while achieving comfort conditions by the start of the scheduled occupied period.
- G. Economizer Mode
1. When outdoor conditions allow and there is a call for cooling, utilize factory controller sequence of operation for enthalpy economizer mode. Integral controller should compare both indoor and outdoor temperatures and indoor and outdoor relative humidity to calculate inside and outside air enthalpy to determine if free economizer operation can cool the space with non-humid outside air. Bypass damper shall be in the open position during economization mode and energy wheel rotation should be off. Mechanical cooling shall be disabled during economizer operation.
- H. Occupied Mode: Supply fan and exhaust fan shall run continuously.
1. Damper Control:
 - a. OA/EA dampers shall open to fully open position during occupied mode.
 - b. During occupied mode, exhaust fan shall operate continuously. Exhaust fan shall operate at a minimum speed to match minimum OA position. Exhaust fan speed shall track OA position with any modulation of mixed air dampers.
 2. Space Temperature Control:
 - a. During active heating mode, the modulating heat output is commanded to control the discharge air temperature to a calculated discharge air temperature setpoint. The calculated discharge air setpoint is based on the zone heating demand and its upper and lower limits will be customer selectable through potentiometers located on the Options module. If the available heating capacity is not sufficient to meet the load demands in the space, the supply fan motor speed will be modulated in order to meet the load.
- I. Unoccupied Mode: With mixed air dampers set to 100% return air position and exhaust fan off, unit fan and heating/cooling operation shall cycle integral control sequences as

required to maintain unoccupied space temperature setpoint (default = 65°F (adj.) in heating mode and 80°F (adj.) in cooling mode).

J. Discharge Air Temperature Reset

1. Heating Mode

- a. During warm-up mode, unit discharge temperature shall reset to 90°F (adj.).
- b. During normal occupied mode, unit discharge temperature shall reset to 70°F (adj.).

K. Scheduling

1. Provide 7-day scheduling with 2 start/stops per day

L. Alarms

1. Provide remote alarm at the BAS work station for the following
 - a. Fan VFD fault.
2. Provide local audio/visual, and remote alarm at the BAS work station for the following
 - a. Fan failure: Commanded ON, but the status is OFF.
 - b. Fan running in hand: commanded OFF, but the status is ON.

M. Data Log

BAS shall be able to trend all monitored values within a period of 1 year. The frequency of recording shall be adjustable from every 1 minute to 1 hour. The trends shall be able to be printed in the Microsoft Excel format with clearly defined headings.

N. Point Summary

Description	Type	Remarks
(1) Space temperature	AI	
(2) Supply fan start/stop	DO	VFD terminal
(3) Supply fan speed	AO	VFD terminal
(4) Supply fan status	DI	VFD terminal
(5) Supply fan VFD fault	DI	VFD terminal
(6) Exhaust fan start/stop	DO	VFD terminal
(7) Exhaust fan speed	AO	VFD terminal
(8) Exhaust fan status	DI	VFD terminal
(9) Exhaust fan VFD fault	DI	VFD terminal
(10) Outdoor Air Flow Rate	AI	
(11) Supply Air Flow Rate	AI	

(12) Return Air Flow Rate	AI	
(13) Exhaust Air Flow Rate	AI	
(14) Supply air static pressure	AI	
(15) Building static pressure	AI	
(16) Outdoor air damper	AO	Modulating
(17) Return air damper	AO	Modulating
(18) Energy wheel bypass damper	AO	Modulating
(19) Gas heat modulation	AO	Modulating
(20) Discharge air temperature	AI	
(21) Return air temperature	AI	
(22) Return air humidity	AI	
(23) Mixed air temperature	AI	
(24) Outside air temperature	AI	
(25) Outside air humidity	AI	
(26) Exhaust leaving wheel temperature	AI	
(27) Supply leaving wheel temperature	AI	
(28) Dirty Filter Switch	DI	
(29) Energy wheel enable	DO	
(30) Energy wheel speed	AO	
(31) Energy wheel status	DI	

END OF SECTION 230993

SECTION 233113 – DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Factory fabricated ducts and fittings.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Shop fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.

6. Fittings.
7. Reinforcement type and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Suspended ceiling components.
 3. Structural members to which ducts will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Penetrations of smoke barriers and fire-rated construction.
 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Fire alarm devices.

- e. Sprinklers.
- f. Access panels.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to the Project Site and store in dry, covered and protected location. Do not store products outdoors.
- B. Protect materials from rust both before and after installation. Ductwork and fittings shall be sealed from dirt and debris.

1.5 WARRANTY

- A. All ductwork systems shall be constructed and erected in a first class workmanlike manner.
- B. The Work shall be guaranteed for a period of one (1) year from the Project Substantial Completion date against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Owner at Contractor's expense.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.
 - c. SEMCO Incorporated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse joints in ducts larger than 30 inches diameter shall be flanged type.

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Solvent-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Base: Synthetic rubber resin.
 - 3. Solvent: Toluene and heptane.
 - 4. Solids Content: Minimum 60 percent.
 - 5. Shore A Hardness: Minimum 60.
 - 6. Water resistant.
 - 7. Mold and mildew resistant.
 - 8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 - 9. Service: Indoor or outdoor.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. 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."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Penetration of the concrete slab is not permitted.

- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

3.7 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
- B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and similar terminal unit equipment less than 2,000 cfm capacity.
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and similar terminal unit equipment less than 2,000 cfm capacity.
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.

- b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - 2. Ducts Connected to Air-Handling Units :
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to Air-Handling Units :
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - F. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3,

"Vaness and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.

- c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

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SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Fire dampers.
3. Smoke dampers.
4. Combination fire and smoke dampers.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Flexible ducts.
8. Duct accessory hardware.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL VOLUME DAMPERS

- A. Gasketed duct fitting with balancing damper for use in systems where a complete shut-off airflow is not required.
 - 1. Gasketed shaft-mounted load bearing bushing to minimize air leakage.
 - 2. Integral blade-shaft assembly.
 - 3. 2-inch sheet metal insulation stand-off collar.
 - 4. Locking blade quadrant with damper position indicator.
 - 5. Lindab DSU or approved equal.

2.3 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Nailor Industries Inc.
 - 3. Ruskin Company.
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Fire Rating: 1-1/2 hours.

- D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.052 or 0.138-inch-thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.

2.4 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Nailor Industries Inc.
 - 3. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- D. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- E. Leakage: Class I.
- F. Rated pressure and velocity to exceed design airflow conditions.
- G. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application.
- H. Damper Motors: two-position action.

- I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 6. Electrical Connection: 115 V, single phase, 60 Hz .

2.5 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Air Balance Inc.; a division of Mestek, Inc.
 2. Nailor Industries Inc.
 3. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with interlocking, gusseted corners and mounting flange.
- F. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- G. Blades: Roll-formed, horizontal, interlocking, 0.063-inch-thick, galvanized sheet steel.
- H. Leakage: Class I.

- I. Rated pressure and velocity to exceed design airflow conditions.
- J. Mounting Sleeve: Factory-installed, 0.05-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- K. Damper Motors: two-position action.
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 - 6. Electrical Connection: 115 V, single phase, 60 Hz.
- L. Accessories:
 - 1. Auxiliary switches for signaling, fan control and position indication.
 - 2. Test and reset switches, remote mounted.

2.6 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.7 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall for ducts up to 24 inches wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. McGill AirFlow LLC.
 - 3. Nailor Industries Inc.
 - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.9 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 1. Minimum Weight: 26 oz./sq. yd..
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F.

- F. 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.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - 1. Minimum Weight: 16 oz./sq. yd.
 - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.
- H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.10 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.

- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.
 - 8. Upstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.
 - 10. Control devices requiring inspection.
 - 11. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- K. Install flexible connectors to connect ducts to equipment.

- L. Connect terminal units to supply ducts directly or with maximum 36 inch lengths of flexible duct. Do not use flexible ducts to change directions.
- M. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

- 1. Operate dampers to verify full range of movement.
- 2. Inspect locations of access doors and verify that purpose of access door can be performed.
- 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
- 4. Inspect turning vanes for proper and secure installation.
- 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

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SECTION 233713 - REGISTERS, GRILLES AND DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope of work is indicated by drawings and by requirements of this section.

1.2 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
 - 1. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
 - 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
 - 3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.
- B. Samples: When requested by the Engineer, submit one (1) sample of each diffuser, register and grille specified. Samples will not be returned.

1.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide registers, grilles and diffusers from the following list of approved manufacturers:
 - 1. Krueger.
 - 2. Nailor.
 - 3. Price.
 - 4. Titus.
- B. Substitutions: Prior approval required as indicated under the general and/or supplemental conditions of these specifications.

2.2 GENERAL

- A. Provide registers, grilles and diffusers having capacities, characteristics and accessories as indicated on the Drawings and specified in this Section.
- B. Provide registers, grilles and diffusers having border types and mounting characteristics compatible with ceiling, wall and floor construction. Refer to Architectural Drawings for materials and methods of construction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

3.2 INSTALLATION

- A. Unless otherwise shown or specified, install the Work of this section in accordance with the manufacturer's printed installation instructions and applicable SMACNA Standards.
- B. Visible ductwork behind registers shall be painted using one coat of flat black metal paint after proper cleaning.
- C. Install diffusers, registers, and grilles level and plumb.
- D. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- E. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes factory-packaged units capable of supplying up to 100 percent outdoor air and providing heating only.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Prepare the following by or under the supervision of a qualified professional engineer:
 - a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - b. Include diagrams for power, signal, and control wiring.
 - c.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof-curb mounting details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.

2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.
- B. Startup service reports.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fan Belts: One set for each belt-driven fan.
 2. Filters: One set for each unit.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Compressors: Five years from date of Substantial Completion.
 2. Warranty Period for Heat Exchangers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with specifications, provide a product by one of the following:
 1. Trane
 2. AAON
 3. Daikin

2.2 CABINET

- A. Construction: Double wall.
- B. Exterior Casing Material: Galvanized steel with paint finish
- C. Interior Casing Material: Galvanized steel.
- D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
- E. Base Rails: Galvanized steel rails for mounting on roof curb or pad as indicated.
- F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- G. Roof: Standing seam or membrane; sloped to drain water.
- H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.
- I. Cabinet Insulation:
 - 1. Type: Fibrous-glass duct lining complying with ASTM C 1071, Type II
 - 2. Thickness: 2 inches.
 - 3. Insulation Adhesive: Comply with ASTM C 916, Type I.
 - 4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.
 - 5.
- J. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.
- K. Roof Curb: Full-perimeter curb of sheet metal, minimum 24 high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.
 - 1. Comply with requirements in "The NRCA Roofing Manual."
- L. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- M. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with spring isolators.

2.3 INDIRECT-FIRED GAS FURNACE HEATING

A. Furnace Assembly:

1. Factory assembled, piped, and wired.
2. Comply with requirements in NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."
3. AGA Approval: Designed and certified by and bearing label of AGA.

B. Burners:

1. Heat-Exchanger Material: Stainless steel with a minimum thermal efficiency of 80 percent.
2. Fuel: Natural gas.
3. Ignition: Electronically controlled electric spark with flame sensor.

C. Heat-Exchanger Drain Pan Material: Stainless steel.

D. Venting: Gravity vented.

E. Venting: Power vent with integral, motorized centrifugal fan interlocked with gas valve.

F. Safety Controls:

1. Gas Control Valve: Electronic modulating.
2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.4 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood or louver.

B. Materials: Match cabinet.

C. Bird Screen: Comply with requirements in ASHRAE 62.1.

D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.5 FILTERS

A. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Factory-fabricated, viscous-coated, flat-panel type.
3. Thickness: 2 inches
4. Minimum MERV: 13, according to ASHRAE 52.2.
5. Media: Interlaced glass fibers sprayed with nonflammable adhesive.

B. Mounting Frames:

1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
2. Extended surface filters arranged for flat orientation, removable from access plenum.
3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks[with space for prefilter.

2.6 ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
- B. Enclosure: NEMA 250, Type 3R, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
1. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

- I. Controls: Factory wire unit-mounted controls where indicated.
- J. Lights: Factory wire unit-mounted lights.
- K. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.
- L. Control Relays: Auxiliary and adjustable time-delay relays.

2.7 CONTROLS

- A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
- B. Control Wiring: Factory wire connection for controls' power supply.
- C. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- D. Control Dampers:
 - 1. Damper Location: Factory installed inside unit for ease of blade axle and bushing service. Arrange dampers located in a mixing box to achieve convergent airflow to minimize stratification.
 - 2. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not exceed 6.5 cfm per sq. ft. at a static-pressure differential of 4.0 inches water column when a torque of 5 inch pounds per sq. ft. is applied to the damper jackshaft.
 - 3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
 - 4. Damper Label: Bear the AMCA seal for both air leakage and performance.
 - 5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service and use modulating control when mixing two airstreams. For other applications, use an opposed-blade configuration.
 - 6. Damper Frame Material: Extruded aluminum
 - 7. Blade Type: Single-thickness metal reinforced with multiple V-grooves or hollow-shaped airfoil.
 - 8. Blade Material: Extruded aluminum
 - 9. Maximum Blade Width: 6 inches
 - 10. Maximum Blade Length: 48 inches
 - 11. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.
 - 12. Bearings: Thrust bearings for vertical blade axles.
 - 13. Airflow Measurement:

- a. Monitoring System: Complete and functioning system of airflow monitoring as an integral part of the damper assembly where indicated.
- b. Remote Monitoring Signal: 0-10 volt or 4-20 mA scaled signal.
- c. Accuracy of flow measurement: Within 5 percent of the actual flow rate between the range of the scheduled minimum and maximum airflow. For units with a large range between minimum and maximum airflow, configure the damper sections and flow measurement assembly as necessary to comply with accuracy.
- d. Straightening Device: Integral to the flow measurement assembly if required to achieve the specified accuracy as installed.
- e. Flow measuring device: Suitable for operation in untreated and unfiltered outdoor air. If necessary, include temperature and altitude compensation and correction to maintain the accuracy.

E. Damper Operators:

1. Factory-installed electric operator for each damper assembly with one operator for each damper assembly mounted to the damper frame.
2. Operator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.
3. Maximum Operating Time: Open or close damper 90 degrees in 60 seconds.
4. Adjustable Stops: For both maximum and minimum positions.
5. Position Indicator and Graduated Scale: Factory installed on each actuator with words "OPEN" and "CLOSED," or similar identification, at travel limits.
6. Spring-return operator to fail-safe; either closed or open as required by application.
7. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.
8. Position feedback Signal: For remote monitoring of damper position.
9. Coupling: V-bolt and V-shaped, toothed cradle.
10. Circuitry: Electronic overload or digital rotation-sensing circuitry.

F. Furnace Controls:

1. Remote sensor for field installation in supply-air duct with sensor adjustment located in control panel to modulate gas furnace burner to maintain space temperature.
2. Electromechanical or Electronic Burner Control: 20 to 100 percent modulation of the firing rate; 10 to 100 percent with dual-furnace units.

G. Integral Smoke Alarm: Smoke detector installed in supply and return air.

2.8 ACCESSORIES

- A. Duplex Receptacle: Factory mounted in unit supply-fan section, with 20 amp 120 V GFI duplex receptacle and weatherproof cover.

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 piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."
 - 1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
 - 2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
 - 3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.
- C. Restrained Curb Support: Install restrained vibration isolation roof-curb rails on roof structure according to "The NRCA Roofing Manual."
- D. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

- E. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."
- F. Install separate devices furnished by manufacturer and not factory installed.
- G. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Gas Piping Connections:
 - 1. Comply with requirements in Section 231123 "Natural-Gas Piping."
 - 2. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
 - 3. Install AGA-approved flexible connectors.
- C. Duct Connections:
 - 1. Comply with requirements in Section 233113 "Metal Ducts."
 - 2. Drawings indicate the general arrangement of ducts.
 - 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."
- D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.
 - 1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Inspect units for visible damage to furnace combustion chamber.
 - 3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
 - a. Measure gas pressure at manifold.
 - b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure flue-gas temperature at furnace discharge.

- d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
4. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-limit heat exchanger.
 - b. Alarms.
5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
6. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 - c. Condenser coil entering-air dry-bulb temperature.
 - d. Condenser coil leaving-air dry-bulb temperature.
7. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
8. Inspect casing insulation for integrity, moisture content, and adhesion.
9. Verify that clearances have been provided for servicing.
10. Verify that controls are connected and operable.
11. Verify that filters are installed.
12. Clean coils and inspect for construction debris.
13. Clean furnace flue and inspect for construction debris.
14. Inspect operation of power vents.
15. Purge gas line.
16. Inspect and adjust vibration isolators and seismic restraints.
17. Verify bearing lubrication.
18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
19. Adjust fan belts to proper alignment and tension.
20. Start unit.
21. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
22. Operate unit for run-in period.
23. Calibrate controls.

24. Adjust and inspect high-temperature limits.
25. Inspect outdoor-air dampers for proper stroke.
26. Verify operational sequence of controls.
27. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air flow.
 - c. Outdoor-air flow.

- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from 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 Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 237433

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SECTION 260010 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Basic administrative and procedural requirements, and general requirements for electrical products and installation, applicable to all Division 26 work.
- B. This Section also applies to all Division 27 & 28 work. Wherever reference is made to "Division 26" (Electrical) such reference shall also mean Division 27 (Communications) and Division 28 (Electronic Safety and Security).

1.2 RELATED DOCUMENTS

- A. Bidding Requirements, Contract Forms, and Conditions of the Contract (General and Supplementary Conditions) and the Drawings apply to all work of Division 26.
- B. Comply with Division 1 - General Requirements.
- C. All work under this Division shall be in accordance with the Contract Documents, as defined in the General Conditions.

1.3 SCOPE OF WORK

- A. General: Provide all supervision, labor, fees, licenses, materials, incidentals, tools, equipment, transportation, hoisting, scaffolding, and services necessary for and incidental to completion of all electrical work as indicated on the Drawings, specified herein, and/or indicated elsewhere in the Contract Documents.
- B. Lifts: Provide Genie lifts, tilting scissors lifts, and/or atrium and other lifts as necessary to perform required work (e.g. in Auditorium, Stage and other rooms with high ceilings).
- C. Whitney Auditorium Catwalk (and Above Ceiling) Level: Provide temporary OSHA planking, ladders, catwalks, walkways, properly and security fastened to above ceiling building structure as needed to perform all required electrical work. Remove all such temporary provisions when no longer needed, unless otherwise approved by the Owner and Architect.
- D. Start-up and Testing: Perform start-up and testing for each electrical item and system, to provide fully operable systems.

1.4 CONFLICTS

- A. General: If, in the interpretation of contract documents, it appears that the drawings and specifications are not in agreement, the Contractor is to contact the Engineer. The Engineer shall be the final authority. Addenda supersede the provisions which they amend.
- B. Approval: In the absence of a written clarification by the engineer, install work in accordance with the more stringent and/or costly condition. Contractor assumes full responsibility for any and all items furnished and installed without the written approval by the Architect/Engineer. Under no circumstances will a change order be accepted for work installed that was not approved by the Architect/Engineer.

1.5 ABBREVIATIONS AND DEFINITIONS

- A. Abbreviations:
 - 1. EC: The Contractor performing the Electrical work.
 - 2. MC: The Contractor performing the Heating, Ventilating, Air Conditioning, and Mechanical work.
 - 3. PC: The Contractor performing the Plumbing work.
 - 4. GC: The Contractor performing the General building work.
 - 5. CM: The Construction Manager.
- B. References to the above designations are not intended to define contracts and/or subcontracts but only as reference to where items are shown on drawings or described in specifications.
- C. Definitions:
 - 1. Concealed: Embedded in masonry or other construction, installed behind wall furring, within partitions or hung ceilings (permanent or removable), in trenches, or in crawl spaces.
 - 2. Exposed: Not installed underground or concealed.
 - 3. Noted: As indicated on the drawings and/or specified.
 - 4. Indicated or Shown: As indicated or shown on the Drawings.
 - 5. Wiring: Conduits, fittings, wire, junction and outlet boxes, switches, cutouts, and receptacles and items necessary or required in connection with or relating thereto.
 - 6. Provide: Furnish and install.

1.6 DRAWINGS AND SPECIFICATIONS

- A. Drawing Use: The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions or details. Install work

substantially as indicated. Exact equipment locations and raceway routing, etc. shall be governed by actual field conditions and/or instructions of the Architect/Engineer.

- B. Interpretation: If, in the interpretation of contract documents, it appears that the drawings and/or specifications are not in agreement, the one requiring the greater quantity or superior quality shall prevail, as decided by the Architect/Engineer. Addenda supersede the provisions which they amend.
- C. Complete Systems: Provide all materials as required for complete systems, including all parts and labor obviously or reasonably incidental to a complete installation, whether specifically indicated or not. All systems shall be completely assembled, tested, adjusted and demonstrated to be fully operational, prior to Owner's acceptance.
- D. Wiring: The wiring specified and/or shown on the Drawings is for complete and workable systems. Any deviations from the wiring shown due to a particular manufacturer's or subcontractor's requirements shall be made at no cost to either the Contract or the Owner.
- E. Review and Inclusions: After review of the drawings and specifications, the EC shall be completely familiar with the function of all items included, and his bid shall reflect the inclusion of all hangers, racks, inserts, etc., necessary for complete and operable systems. The EC shall provide offsets, fittings and accessories as may be required to meet project field conditions. The EC shall make all changes in equipment, locations, etc., to accommodate the work and to avoid obstacles at no increase in remuneration.
- F. Field Dimensions: All dimensions which relate to the building shall be taken as construction progresses. All errors incurred as a result of the EC's failure to check or verify dimensions, measurements, etc., shall be corrected at the EC's expense.
- G. Work of Other Trades: The Contractor shall review the contract documents for the work of other trades, informing the Architect/Engineer of any conditions which obstruct, interfere with, or in any way prevent him from completing his work in a first class manner.

1.7 MISCELLANEOUS REQUIREMENTS

- A. Control Power: Provide 120-volt power to control panels provided by other trades, as required.
- B. Minor Items: Work also includes minor items which may not be shown or mentioned, but are necessary for a complete, working electrical installation.
- C. Temporary Power and Lighting: Provide as required for construction operations and for ample job site security, and per Division 1.

- D. Tests and Adjustments: The EC shall furnish testing equipment, instruments and personnel to perform all test procedures and adjustments required by the National Electrical Code, the utility company and the authority having jurisdiction to establish proper performance and installation of electrical equipment and materials.

1.8 CODES AND STANDARDS

- A. Requirements of Regulatory Agencies: Applicable local, state and national laws, statutes, building codes and regulations as well as utility company requirements shall govern the complete installation.
- B. Permits: Obtain permits and pay all fees required by the local inspecting authority.
- C. Reference Standards: The latest applicable recognized editions of the following codes, standards, and specifications shall be considered minimum requirements.
 - 1. (ADA) Americans with Disabilities Act
 - 2. (ANSI) American National Standards Institute
 - 3. (ASTM) American Society for Testing and Materials
 - 4. (CBM) Certified Ballast Manufacturers
 - 5. (ETL) Electrical Testing Laboratories
 - 6. (IBC) International Building Code
 - 7. (ICEA) Insulated Cable Engineers Association
 - 8. (IEBC) International Existing Building Code
 - 9. (IECC) International Energy Conservation Code
 - 10. (IEEE) Inst. of Electrical and Electronics Engineers
 - 11. (IES) Illuminating Engineering Society
 - 12. (IFC) International Fire Code
 - 13. (IPCEA) Insulated Power Cable Engineers Association
 - 14. (IRC) International Residential Code
 - 15. (ITL) Independent Testing Laboratories
 - 16. (NETA) International Electrical Testing Association
 - 17. (NBFU) National Board of Fire Underwriters
 - 18. (NEMA) National Electrical Manufacturers Association
 - 19. (NESC) National Electric Safety Code
 - 20. (NFPA) National Fire Protection Association
 - 21. (UL) Underwriters' Laboratories
 - 22. Local Codes
 - 23. Public Health Service Regulations
 - 24. Local Utility Standards and Regulations

1.9 PERMITS

- A. General: Obtain all permits required for electrical work on the Project by all governing agencies having jurisdiction at the Project site.

1.10 QUALITY ASSURANCE

- A. Manufacturers' Qualifications: Not less than (3) years' experience in the actual production of the specified (or similar) products.
- B. Installers' Qualifications: Firm having not less than (5) years' experience in the installation of electrical systems and equipment similar in scope and complexity to those required for this Project and having successfully completed at least ten comparable scale projects.
- C. Incidental Work: Painting, patching, welding, carpentry and the like related to or required for Division 26 work shall be performed by craftsmen skilled in the appropriate trade, and shall be provided for under Division 26, unless indicated otherwise.

1.11 SUBMITTALS

- A. General: Prepare and submit for approval, all submittals required by this and subsequent Division 26 sections, and by all other Contract Documents for this Project.
- B. Types: Required submittals may include: Schedule of Values; List of Subcontractors and Materials; Product Data; Shop Drawings; Samples; Test Reports; Certifications; Warranties; Maintenance Manuals; Record Documents; Rebate Applications (including all submittals, backup information, copies of receipts, etc. needed to obtain all applicable electric utility company incentives); and other various administrative submittals.
- C. Number and Format: One electronic PDF format copy.
- D. Product Data: Submit for equipment, devices and materials as required in subsequent individual Division 26 sections. Product Data to consist of manufacturer's standard catalog cuts, descriptive literature and/or diagrams, in 8-1/2" X 11" format, and in sufficient detail so as to clearly indicate compliance with all specified requirements and applicable standards. Mark each copy to clearly indicate proposed product, included options, accessories, finish, size, type, etc.
- E. Shop Drawings: Submit for equipment and systems as required in subsequent individual Division 26 sections. Shop Drawings to be newly prepared, specifically for this project, and shall include all information listed in the shop drawing submittal requirements in the respective specification section. Include all pertinent information such as equipment/system identification, manufacturer, and model or series number where applicable, dimensions, nameplate data, sizes, capacities, types, fabrication materials, materials list, performance data, features, accessories, wiring diagrams, etc. in sufficient

detail so as to clearly indicate compliance with all specified requirements and applicable standards. Submit Shop Drawings with related Product Data submittals.

- F. Operation and Maintenance Data: Upon completion of the work, prepare and deliver to the Owner complete operating and maintenance manuals for systems and major equipment installed as outlined in Division 1 of the project specifications. Include all updated materials listed above in submission, including as-built wiring diagrams.
- G. Maintenance Manuals: Include operating and maintenance data for each Division 26 section requiring a Product Data and/or Shop Drawing submittal. Include the respective Product Data/Shop Drawing submittals as well as descriptions of function, normal operating characteristics and limitations, and manufacturer's printed operating, maintenance, trouble shooting, repair, adjustment and emergency instructions and diagrams, complete replacement parts listing, and the name, address and telephone number of the installing contractor and/or subcontractor, and for the nearest manufacturer's authorized service dealer.
- H. Record Documents: Prepare and submit in accordance with Division 1. In addition to Division 1 requirements, indicate actual installed locations for all electrical equipment and devices, routing of major interior building raceways, locations of all concealed and underground equipment and raceways, and all approved modifications to the Contract Documents, and deviations necessitated by field conditions and change orders.

1.12 INSPECTIONS

- A. General: During and upon completion of the work, arrange and pay all associated costs for inspections of all electrical work installed for the Project, in accordance with the Conditions of the Contract and this Section.
- B. Coordination: Coordinate and schedule all inspections with the Authority Having Jurisdiction as required. Coordinate inspections with requirements of the serving electric utility company.
- C. Inspections Required: Electrical rough-in inspection(s) and final electrical inspection(s) for all areas of building(s) where electrical work is being performed, and all site electrical work, and any other inspections required by the Authority Having Jurisdiction.
- D. Inspection Agency: Inspections shall be performed by an independent third party, approved inspection agency listed with the local building department.
- E. Certificates: Submit copies of all rough-in inspection certificates and all final inspection approval certificates to the Construction Manager, prior to requesting final payment(s).

1.13 PROJECT CONDITIONS

- A. Existing Conditions: Field verify all conditions that will determine exact locations, distances, levels, dimensions, elevations, etc. Review all drawings of other trades and report any conflicts to the Architect/Engineer which will affect the project cost.
- B. Dimensions: Dimensional information used for layout and locations shall be taken from architectural or structural drawings used by the construction trades and by field dimensions.
- C. Locations: Certain electrical drawings are diagrammatic and have no dimensional significance. Locations of equipment are to be as:
 - 1. Shown on the dimensioned drawings.
 - 2. Directed in the field.
 - 3. Required for proper connection of equipment to be served.
 - 4. Required for proper symmetry in the space involved.
 - 5. With deviations made only with specific approval of Architect/Engineer.
- D. Coordination with the Other Trades: Division 26 shall review the drawings of other divisions, exchange shop drawings with them and cooperate in the preparation of space layouts as required to avoid conflicts and interferences with the installation of other trades in advanced stages of construction. Refer to Division 1 specification sections.
- E. Outlet Locations: The Architect reserves the right to relocate an outlet or outlets, 5' in any direction from locations indicated on plans, before roughing-in, with no change in contract price.

1.14 FIELD OBSERVATION REPORTS

- A. General: The EC shall receive field observation report(s) prepared by the Architect/Engineer. These field observation report(s) shall contain items which need further attention by the EC in order to fulfill the obligations of the contract. These field observation report(s) have space provided for the EC to sign off on each item when completed. The completion of the work listed on these field observation report(s) and the return of these signed off field observation report(s) to the Architect/Engineer by the EC is required to complete the contract obligation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Where Specified: Division 26 materials and equipment shall be as specified in subsequent Division 26 sections, and/or as indicated on the Drawings.

- B. General Requirements: All materials and equipment shall be in accordance with the Contract Documents, and to the extent possible, standard products (except where special construction or performance features are called for) of the specified or approved manufacturers. All materials and equipment shall be new, clean, undamaged, and free of defects and corrosion.
- C. Acceptable Products: The product of a specified or approved manufacturer will be acceptable only when that product complies with or is modified as necessary to comply with all requirements of the Contract Documents.
- D. Conformance: The EC shall verify that all materials he or his suppliers select conform to the requirements of the Drawings and Specifications. Transmittal of drawing and specification information to manufacturers supplying materials, and adherence to these requirements is the EC's responsibility. Approval of manufacturer's name by the Architect/Engineer does not release the EC of the responsibility for providing materials which comply in all respects with the requirements in the Contract Documents.
- E. Common Items: Where more than one of any specific item is required, all shall be of the same type and manufacturer.
- F. UL Listing: All electrical materials and equipment shall be Underwriters' Laboratories (UL) listed and labeled, where UL standards and listings exist for such materials or equipment.
- G. Permission to substitute equal or superior items of materials and equipment may be requested by following the procedure outlined in the Division 1 "Substitutions" of the project specifications. Completion date will not be extended because of any time lost due to consideration or installation of substitutions. All coordination of substituted equipment shall be the Contractor's responsibility.
- H. In purchasing materials and equipment to be furnished and installed under this contract the contractor shall convey to the Owner all rights and privileges extended by the various manufacturers thereof in the form of warranties and guarantees covering quality and performance of such items.
- I. All electric materials and equipment are to comply with all utility company requirements, where applicable.

PART 3 - EXECUTION

3.1 GENERAL

- A. Letter and Intent: The installation of all electrical work shall be in accordance with the letter and intent of the Contract Documents, as determined by the Architect/Engineer.

- B. Installation Requirements: All materials and equipment shall be installed as recommended by the respective manufacturers, by mechanics skilled in the particular trade, in a neat and workmanlike manner, in accordance with the standards of the trade, and so as not to void any warranty or UL listing.
- C. Administration and Supervision: All electrical work shall be performed under the Contractor's direct supervision, using sufficient and qualified personnel as necessary to complete the work in accordance with the project progress and completion schedule. The Contractor shall assign one or more competent supervisors who shall have authority to accept and execute orders and instructions, and who shall cooperate with the Architect/Engineer and the Owner in all matters to resolve conflicts, avoid delays and complete the Project as efficiently as possible.

3.2 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with Division 1 requirements.
- B. Packing and Shipping: Deliver products to the Project site in original, unopened packaging, properly identified with the manufacturer's identification and shipping and handling instructions, and compliance labels.
- C. Delivery and Storage: Make provisions for delivery and safe storage of all materials. Check and properly receipt material to be "furnished by others" and assume full responsibility for all materials while in storage with full visible identification information.
- D. Storage Requirements: Comply with all manufacturer's written storage instructions and recommendations. Store all products in a manner which shall protect them from vandalism, damage, weather elements, and entry of debris.
- E. Large Equipment: Make the required arrangements with General Contractor for the introduction into the building of equipment too large to pass through finished openings.
- F. Damaged Products: Do not install damaged products. Arrange for prompt undamaged replacement.

3.3 EXAMINATION

- A. Conditions Verification: Examine the areas where, and conditions under which the work is to be performed, and identify any conditions detrimental to the proper and timely completion of the work. Do not proceed until the unsatisfactory conditions have been corrected or are no longer present.

3.4 COORDINATION

- A. General: Sequence, coordinate and integrate the installation of all electrical materials and equipment for efficient flow of work, in conjunction with the other trades. Review the Drawings for work of the other trades, and report and cooperate to resolve any discovered discrepancies, prior to commencing work.
- B. Cooperation: Cooperate with the other Contractors and individual disciplines for placement, anchorage and accomplishment of the work. Resolve and minimize possible interferences in the work, prior to commencing installation.
- C. Chases, Slots and Openings: Arrange for chases, slots and openings during the progress of construction, as required to allow for installation of the electrical work.
- D. Supports and Sleeves: Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- E. Obstacles and Interferences: When installing equipment and raceways, provide offsets, fittings, accessories and changes in elevation or location as necessary to avoid obstacles and interferences, per actual field conditions.

3.5 DIMENSIONS

- A. Building Dimensions: For exact locations of building elements, refer to dimensioned drawings. However, field measurements take precedence over dimensioned drawings.
- B. Limiting Dimensions: Equipment outlines shown on drawings or details of 1/4"= 1'-0" scale or larger, and dimensions indicated on the Drawings are limiting dimensions. Do not install equipment exceeding these dimensions unless specifically approved by the Architect/Engineer.

3.6 PROTECTION OF MATERIALS AND EQUIPMENT

- A. General: Protect all electrical work, materials, equipment, fixtures and devices from weather elements, paint, concrete, mortar, construction debris, theft, vandalism and damage throughout the construction period until final acceptance. Promptly replace any such damaged electrical work, materials, equipment, fixtures, devices.

3.7 CHECKOUT, TESTING AND ADJUSTMENTS

- A. Requirements: Schedule and provide testing equipment, materials, instruments and personnel as necessary to checkout and perform all test procedures and adjustments required by the respective manufacturer's written instructions or recommendations, the Contract Documents, and/or deemed necessary by the Architect/Engineer or Authority Having Jurisdiction to establish proper performance and installation of all electrical

systems and equipment. All test instruments to be accurately calibrated and in good working order.

- B. Checkout: In addition to the above testing, perform the following checkouts:
- C. Wiring: Check all wiring for continuity and grounds before energizing any system.
- D. Fixtures and Equipment: Check for grounds, shorts, etc. on all fixtures, equipment, apparatus, etc.
- E. Heat Tests: Load test various parts of the system as directed by the Architect/Engineer, to determine if excessive heat is developed in panels, switches, wiring, etc.
- F. Test Scheduling: Coordinate and schedule tests at least one week in advance, and so as to allow the Construction Manager's, Architect/Engineer's and Owner's representative(s) to witness the test, unless directed otherwise. Do not schedule tests until the system installation is complete and fully operational, unless directed otherwise by the Engineer.
- G. Manufacturer's Authorized Representatives: When required by subsequent Division 26 sections, arrange and pay for the services of the manufacturer's authorized representative(s) to be on-site to supervise the start-up, checkout, testing and adjusting of the equipment or system, and to certify all required testing and adjusting.
- H. Test Reports: Submit test reports neatly typewritten on 8 1/2" X 11" sheets indicating system or equipment being tested, methodology of testing, date and time of test, witnesses of test, and test results. Submit test report in PDF format to the Construction Manager for review, within five days after test is performed, and include a copy in the appropriate section of the Maintenance Manual.
- I. Correction/Replacement: After testing, correct any deficiencies, and replace materials and equipment shown to be defective or unable to perform at design or rated capacity. Re-test without additional cost to the Owner or Contract. Submit finalization report indicating corrective measures taken, and satisfactory results of re-test.
- J. Other Tests: Perform all testing as required by the Authority Having Jurisdiction, as may be required by serving electric utility company, and as required in all other Division 26 sections.

3.8 SYSTEMS DEMONSTRATION

- A. General: Instruct the Owner's representative(s) in the start-up, operation and maintenance of all electrical systems and equipment. Comply with specific requirements in subsequent Division 26 sections. All systems demonstrations shall be to the Owner's satisfaction.

3.9 CLEANING

- A. Perform cleaning as required by Division 1.
- B. General Cleaning: Periodically remove from the Project site, all waste, rubbish and construction debris accumulated from construction operations, and maintain order. The premises shall be left clean and free of any debris and unused construction materials, prior to Owner's acceptance.
- C. Electrical Equipment: Remove all dust, dirt, debris, mortar, wire scraps, rust and other foreign materials from the interior and exterior of all electrical equipment and enclosures and wipe down. Clean accessible current carrying elements and insulators prior to energizing.
- D. Lighting Fixtures: Thoroughly clean all lighting fixtures and lamps, just prior to final inspection. Fixture housings, reflectors, lenses, etc. shall be cleaned free of any dust, dirt, fingerprints, etc. by an approved method.
- E. Touch-Up Painting: Restore and refinish to original condition, all surfaces of electrical equipment scratched, marred and/or dented during shipping, handling or installation. Remove all rust, and prime and paint as recommended by the manufacturer.

END OF SECTION 260010

SECTION 260050 - GENERAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: General requirements, and basic materials and methods applicable for all Division 26 work. Limited scope general construction materials and methods for application with electrical installations are also included.
- B. This section also applies to all Division 27 and 28 work.

1.2 SUBMITTALS

- A. None Required.

PART 2 - PRODUCTS

2.1 PIPE SLEEVES

- A. Rigid steel conduit or iron pipe.

2.2 CONDUIT SEALS

- A. For Cast-in-Place Concrete Applications: Acceptable Manufacturers: O-Z/Gedney Type "FSK"; Thunderline Corp. "Link Seal Wall Sleeve".
- B. For Core Drill and Pre-Cast Opening Applications: O-Z/Gedney Type "CSML"; Thunderline Corp. "Link Seal".

2.3 FIRESTOPPING MATERIALS

- A. Requirements: Comply with Division 7 and the following.
- B. General: Firestopping systems composed of firestopping compounds and appropriate damming materials installed together with the penetrant (e.g. conduit) to form a complete firestopping system, providing a fire resistant rating at least equal to the hourly fire resistance rating of the floor, wall or partition into which the firestopping system is to be installed.

- C. Test Standards: Firestopping materials shall be tested together as a system to the time/temperature requirements of ASTM E119 and shall be tested to UL 1479 (ASTM E814) and be UL classified for up to (3) hours.
- D. Firestopping Sealants: Non-hardening, conformable, intumescent putties, sealants or other compounds, containing no toxic solvents or asbestos, and exhibiting aggressive adhesion to all common building materials and penetrants, while allowing reasonable movement of the penetrants, without being displaced. Compounds shall be waterproof, non-toxic and smoke and gas tight.
- E. Firestopping Mortars: Light-weight, water-based, cementitious, fast-drying, low density mortar, non-shrinking and non-cracking during its cure, and which forms a surface capable of being sanded, bored and painted.
- F. Damming Materials: Mineral wool or ceramic fiber.
- G. Acceptable Manufacturers: Dow Corning; Heavy Duty/Nelson; International Protective Coatings; Specified Technologies, Inc.

PART 3 - EXECUTION

3.1 ELECTRICAL INSTALLATION

- A. Finished and Unfinished Areas: For the purposes of these electrical specifications, the Whitney Auditorium Stage and mechanical and electrical equipment rooms shall be considered "unfinished" areas. All other areas of the building shall be considered "finished" spaces, unless approved otherwise by the Architect/Engineer.
- B. In Unfinished Areas: Raceways, equipment and devices may be installed concealed or exposed, unless indicated otherwise.
- C. In Finished Areas: Conceal all raceways and flush mount all electrical boxes, equipment, and devices unless specifically indicated or approved otherwise. The space above suspended ceilings or behind furred spaces is considered outside finished areas and electrical materials installed within these areas are considered concealed.
- D. Minimum Mounting Height: Install exposed raceway and all other electrical equipment (e.g., lighting fixtures) with not less than 7'-6" clear to finished floor, unless indicated or approved otherwise, and excluding raceway and equipment mounted on walls.
- E. Dimensions and Clearances: Field measure all dimensions and clearances affecting the installation of electrical work, in relation to established datum, building openings and clearances, and the work of other trades, as construction progresses.

- F. Rough-In Locations: Verify final locations for rough-ins with field measurements and requirements of actual equipment being installed.
- G. Door Swings: Verify the swings of all doors before switch outlet boxes and other electrical device boxes are installed. If necessary, revise outlet box locations so that devices are not obstructed by doors when doors are open.
- H. Equipment Mounted on Interior Side of Exterior Building Walls: When mounting panelboards, safety switches and other electrical equipment on interior side of exterior building walls, provide minimum 1/2" plywood mounting backboard.

3.2 LAYOUT

- A. General: Install electrical systems, materials and equipment level and plumb, and parallel and perpendicular to building surfaces, and other building systems components, wherever possible.
- B. Serviceability: Install electrical equipment and raceways, etc. so as to readily facilitate servicing, maintenance and repair or replacement of the equipment or its components, and so as to minimize interference with other equipment and installations.
- C. Clearances: Prior to commencing work, verify that all electrical equipment will adequately fit and conform to the indicated and NEC required clearances, in the spaces indicated on the Drawings. If rearrangement is required, submit plan and elevation drawings or sketches indicating proposed rearrangement, for Architect/Engineer approval. Do not rearrange equipment layouts without the written permission of the Architect/Engineer.
- D. Right-of-Way: When laying out electrical work, give priority in available spaces to new and existing steam and condensate lines, sanitary lines, drain lines, fire protection system piping, and sheet metal duct work. Provide offsets as necessary to avoid conflicts. Resolve all conflicts before commencing installation.

3.3 MOUNTING HEIGHTS

- A. General: Indicated heights are measured from the center of the device outlet box to the finished floor or grade, unless indicated otherwise. Request instructions for mounting heights not indicated.
- B. Adjustments: Adjust mounting heights in exposed masonry construction so that bottoms of outlet boxes are along the edges of blocks, unless indicated otherwise.

3.4 HOLES, SLEEVES AND OPENINGS

- A. General: Provide all holes, sleeves and openings required for the completion of Division 26 work and restore all surfaces damaged, to match surrounding surfaces. Maintain integrity of all new and existing fire and smoke rated barriers, using approved firestopping systems. When cutting holes or openings, or installing sleeves, do not cut, damage or disturb structural elements or reinforcing steel, unless approved, in writing, by the Architect/Engineer.
- B. Conduit Penetrations: Size core drilled holes so that an annular space of 1/4" to 1" is left around the circumference of the conduit. When openings are cut in lieu of core drilled, provide sleeve in rough opening. Size sleeves to provide an annular space of 1/4" to 1" around the circumference of the conduit. Patch around sleeve to match surrounding surfaces.

3.5 CONDUIT SEALS

- A. General: Install conduit seal for each conduit penetrating an exterior building wall below grade (unless penetration is below lowest building floor slab), and elsewhere as indicated or required. Install seals so as to achieve a watertight installation.

3.6 CUTTING AND PATCHING

- A. General: Provide all cutting, drilling, chasing, fitting and patching necessary for accomplishing the work of Division 26. This includes any and all work necessary: to uncover materials to provide for the installation of ill-timed work; to remove and replace defective work and work not conforming to the Contract Documents; to install equipment and materials in existing buildings and structures; in addition to that required during the normal course of construction.
- B. Building Structure: Do not endanger the integrity of any building structure by cutting, drilling or otherwise modifying any structural member, without specific approval. Do not proceed with any modifications to building structure without written permission of the Architect/Engineer.
- C. Repairs: Repair any and all damage to work of any other trade on the Project caused by cutting and patching operations, using skilled mechanics of the trade(s) involved.

3.7 FIRESTOPPING SYSTEMS

- A. Requirements: Comply with Division 7 and the following.
- B. General: Install firestopping at all electrical raceway and cable penetrations through floor structures and interior walls or partitions which are time-rated fire and/or smoke barriers. Identify all such barriers from the Architectural Drawings.

- C. Preparation: Prior to installation, verify that all penetrating elements and supporting devices are permanently installed and that surfaces which will be in contact with the penetration sealing materials are clean and free of dust, dirt, grease, oil, loose materials, rust and other foreign substances.
- D. Installation: Install firestopping systems in accordance with UL approved design details and the manufacturer's written instructions. Install sleeves, conduits and cables with required clearance spaces, allowing adequate installation of the sealing materials. Do not exceed the outside diameter of the sleeve, conduit or cable by more than 1" or by less than 1/4" when making openings for penetrations. Install firestopping systems so as to completely seal openings to prevent the passage of smoke and water.

3.8 WELDING

- A. Where welding is required, such welding shall be performed in a skilled manner by certified welders. Verify that all welds are free from cracks, craters, undercuts and strikes, weld spatter, and any other surface defects. Clean and re-weld any welds which are defective in any way.

3.9 ELECTRICAL REMOVALS WORK

- A. General: Remove existing electrical equipment, devices, raceways, wiring and related materials within the Project work limits, as indicated, specified, and required for successful Project completion.
- B. Existing Conditions: In general, existing electrical systems are not shown on the Drawings unless pertinent to the work of this Project. Existing electrical conditions, where indicated, are based on casual field observations and/or drawings for previous construction, and must be field verified. Report any discrepancies to the Architect/Engineer before disturbing the existing installation.
- C. Examination: Prior to bidding, examine the Project site to determine all actual observable conditions, building dimensions, and locations of existing electrical equipment, etc. No additional compensation will be granted on account of extra work made necessary by the Contractor's failure to investigate such existing conditions.
- D. Items to be Salvaged: Before commencing work of this Section, verify with the Owner and Architect/Engineer, which (if any) existing electrical systems, materials, equipment and devices being removed under this Project are to be salvaged.
- E. Inspection: Carefully inspect the Project site and become familiar with the existing systems and conditions, before proceeding with the work.
- F. Coordination: Coordinate all removals and changeover work with the Owner.

- G. Protection of Adjacent Materials: During execution of removals work, give primary consideration to protecting from damage, the building structure, furnishings, finishes and the like, unless specifically indicated to be removed. Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Architect/Engineer, at no cost to the Contract.
- H. Patching: When electrical materials are removed or modified, patch and finish walls, ceilings, floors and other surfaces to match surrounding surfaces. Provide blank coverplates, etc. as required. Materials used for patching shall match existing materials.
- I. Shutdowns: All shutdowns to existing electrical services and systems to be scheduled and approved at least one week in advance, in writing, by the Owner.
- J. Temporary Connections: Where electrical services are required to be temporarily disconnected due to project requirements, provide temporary services to maintain existing operations up until the time permanent services are restored. Coordinate with the Owner.
- K. Disconnections: Disconnect electrical devices and equipment as specified and required.
- L. Wire/Cable Removals: Where existing electrical devices or equipment are indicated or required to be removed, remove all associated wire/cable. Remove all abandoned or dead wiring back to source.
- M. Raceway Removals: Remove all abandoned raceways, boxes, supports, etc., unless indicated otherwise.
- N. Reconnections: Where existing electrical circuits serving existing lighting fixtures, wiring devices, etc. which are to remain (i.e. not indicated to be removed) become disconnected or otherwise disrupted as a result of remodeling work, reroute and reconnect circuits, provide new circuiting, etc. as required to restore original operation to the existing fixtures and devices remaining. Reconnection work to comply with requirements for new work.
- O. Existing Electrical Work to Remain: Protect and maintain access to all existing electrical work indicated and/or required to remain. Repair and reinstall any such existing electrical work disturbed.
- P. Items to be Salvaged: Carefully remove and store on site where directed by the Owner, all material and equipment which is specified, indicated (or directed by the Owner) to be salvaged.
- Q. Items to be Reused/Relocated: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to reinstallation.

- R. Items to be Removed: Remove and legally dispose of all materials (except salvage or relocation items) and debris resulting from demolition work.
- S. Cleaning: Remove from the Project site all dirt, dust and debris, etc. resulting from demolition work, on a daily basis. Do not block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION 260050

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SECTION 260500 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY

- A. The General and Supplementary Conditions are a part of the requirements for the work under this Division of the Specifications.

1.2 WORK INCLUDED

- A. Provide labor and materials required to install, test and place into operation the electrical systems as called for in the Contract Documents, and in accordance with applicable codes and regulations.
- B. Provide labor, materials, and accessories required to provide complete, operating electrical systems. Labor, materials or accessories not specifically called for in the Contract Documents, but required to provide complete, operating electrical systems shall be provided without additional cost to the Owner.

1.3 QUALITY ASSURANCE

- A. Comply with the current applicable codes, ordinances, and regulations of the Authority or Authorities Having Jurisdiction, the rules, regulations and requirements of the utility companies serving the project, and the Owner's insurance underwriter.
- B. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, the most stringent apply.
- C. Should any change in drawings or specifications be required to comply with governing regulations, notify the Engineer prior to submitting bid.
- D. All electrical equipment, materials, devices and installations shall meet or exceed minimum requirements of ADA, ANSI, ASTM, IEEE, IES, NEC, NEMA, NETA, NFPA, OSHA, SMACNA, UL, and the State Fire Marshal.
- E. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workperson-like manner by competent workpeople. Provide a competent, experienced, full-time Superintendent who is authorized to make decisions on behalf of the Contractor.

- F. Equipment shall be certified for use in the state of New York and shall meet the New York State energy code.

1.4 ABBREVIATIONS AND DEFINITIONS

A. Abbreviations:

- | | | |
|-----|--------|--|
| 1. | ADA | Americans with Disabilities Act |
| 2. | ANSI | American National Standards Institute |
| 3. | ASA | Acoustical Society of America |
| 4. | ASTM | American Society for Testing and Materials |
| 5. | BIL | Basic Impulse Level |
| 6. | CBM | Certified Ballast Manufacturers |
| 7. | ECC | Engineer's Control Center |
| 8. | EIA | Electronic Industries Alliance |
| 9. | ETL | Electrical Testing Laboratories, Inc. |
| 10. | FCC | Fire Control Center |
| 11. | FM | Factory Mutual |
| 12. | IEEE | Institute of Electrical and Electronic Engineers |
| 13. | IES | Illuminating Engineering Society |
| 14. | IPCEA | International Power Cable Engineers Association |
| 15. | LED | Light Emitting Diode |
| 16. | NEC | National Electric Code |
| 17. | NEMA | National Electrical Manufacturers Association |
| 18. | NETA | National Electrical Testing Association |
| 19. | NFPA | National Fire Protection Association |
| 20. | OEM | Original Equipment Manufacturer |
| 21. | OSHA | Occupational Safety and Health Administration |
| 22. | SCC | Security Control Center |
| 23. | SMACNA | Sheet Metal and Air Conditioning Contractors
National Association |
| 24. | TIA | Telecommunications Industry Association |
| 25. | UL | Underwriters Laboratories Inc. |

B. Definitions:

1. Where it is stated in these specifications to submit to Engineer for review, refer to Architectural General and Supplementary Conditions for proper procedures.
2. FURNISH means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application.

3. INSTALL means to join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation.
4. PROVIDE means to FURNISH and INSTALL.
5. AS DIRECTED means as directed by the Engineer, or the Engineer's Representative.
6. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
7. SUBMIT means submit to Engineer for review.

1.5 GUARANTEE

- A. Submit a single guarantee stating that the work is in accordance with the Contract Documents. Guarantee work against faulty and improper material and workmanship for a period of one year from the date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are provided or specified herein, the longer term shall apply. Manufacturer's warranty/guarantee on equipment shall be begin at time of equipment startup not upon receipt of equipment. Correct any deficiencies, which occur during the guarantee period, within 24 hours of notification, without additional cost to the Owner, to the satisfaction of the Owner. Obtain similar guarantees from subcontractors, manufacturers, suppliers and subtrade specialists.

PART 2 – PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.
- B. Products and materials shall not contain asbestos, PCB, or any other material that is considered hazardous by the Environmental Protection Agency or any other Authority Having Jurisdiction.
- C. Replace materials of less than specified quality and relocate work incorrectly installed as directed by the Architect or Engineer at no additional cost to the Owner.
- D. Provide name/data plates on major components of equipment with manufacturer's name, model number, serial number, capacity data and electrical characteristics attached in a conspicuous place.

- E. Install materials and equipment with qualified trades people.
- F. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.
- G. Fully lubricate equipment where required.
- H. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.
- I. Where factory testing of equipment is required to ascertain performance, and attendance by the Owner's Representative is required to witness such tests, associated travel costs and subsistence shall be paid for by the Contractor.
- J. Equipment capacities, ratings, etc., are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be derated with the method of derating identified on the submittals.
- K. Enclosures for electrical equipment installed in mechanical and electrical equipment rooms shall be NEMA type 1 gasketed. Enclosures for electrical equipment installed outdoors shall be NEMA type 3R.
- L. Energy consuming equipment shall be certified for use in the state of New York and shall meet the New York State Energy Code and local energy ordinances.

2.2 SUBSTITUTIONS

- A. Contract Documents are based on equipment manufacturers as called out in the Specifications and indicated on the Drawings. Acceptance of substitute equipment manufacturers does not relieve Contractor of the responsibility to provide equipment and materials, which meet the performance as, stated or implied in the Contract Documents.
- B. Submit proposals to provide substitute materials or equipment, in writing, with sufficient lead time for review prior to the date equipment must be ordered to maintain project schedule. Reimburse Owner for costs associated with the review of the proposed substitution whether substitution is accepted or rejected.
- C. Indicate revisions required to adapt substitutions including revisions by other trades. Substitutions that increase the cost of the work and related trades are not permitted.

- D. The proposed substitution shall conform to the size, ratings, and operating characteristics of the equipment or systems as specified and shown on the Drawings.
- E. Proposals for substitutions shall include the following information:
 - 1. A description of the difference between the Contract Document requirements and that of the substitution, the comparative features of each, and the effect of the change on the end result performance. Include the impact of all changes on other contractors and acknowledge the inclusion of additional costs to the other trades.
 - 2. Schematic drawings and details.
 - 3. List of revisions to the Contract Documents that must be made if the substitution is accepted.
 - 4. Estimate of costs the Owner may incur in implementing the substitution, such as test, evaluation, operating and support costs.
 - 5. Statement of the time by which a Contract modification accepting the substitution must be issued, noting any effect on the Contract completion time or the delivery schedule.
 - 6. A statement indicating the reduction to the Contract price if the Owner accepts the substitution. Include required modifications to all related trades.

PART 3 – EXECUTION

3.1 FEES AND PERMITS

- A. Pay all required fees and obtain all required permits related to the electrical installation.
- B. Pay royalties or fees in connection with the use of patented devices and systems.
- C. Provide controlled inspection where required by Authorities Having Jurisdiction or by these specifications.

3.2 SUBMITTALS AND REVIEWS

- A. Submit shop drawings, manufacturer's product data sheets, samples, and test reports as specified.
- B. After execution of Owner/Contractor Agreement, submit a complete typed list of all electrical equipment manufacturers and material suppliers for the equipment proposed to be provided on this project, as well as names of all subcontractors.

- C. After execution of Owner/Contractor Agreement, prepare an index of all submittals for the project. Include a submittal identification number, a cross-reference to the Specification sections or Drawing number, and an item description. Prefix the submittal identification number by the Specification sections to which they apply. Indicate on each submittal, the submittal identification number in addition to the other data specified. All subcontractors shall utilize the assigned submittal identification number.
- D. After the Contract is awarded, obtain complete shop drawings, product data and samples from the manufacturers, suppliers, vendors, and all subcontractors, for all materials and equipment as specified. Submit data and details of such materials and equipment for review. Prior to submission, certify that the shop drawings, product data and samples are in compliance with the Contract Documents. Check all materials and equipment upon their arrival on the job site and verify their compliance with the Contract Documents. Modify any work, which proceeds prior to receiving accepted shop drawings as required to comply with the Contract Documents and the shop drawings.
- E. Review of submittals is for general compliance with the design concept and Contract Documents. Comments or absence of comments shall not relieve the Contractor from compliance with the Contract Documents. The Contractor remains solely responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of construction, for performing the work in a safe manner, and for coordinating the work with that of other trades.
- F. No part of the work shall be started in the shop or in the field until the shop drawings and samples for that portion of the work have been submitted and accepted.
- G. A minimum period of ten working days, exclusive of transmittal time, will be required in the Engineer's office each time a shop drawing, product data and/or samples are submitted for review. This time period must be considered by the Contractor in the scheduling of the work.
- H. Submit electronic copies, preferably in PDF format, of all items requiring shop drawings.
- I. Submit materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalog material. Maintenance and operating manuals are not acceptable substitutes for shop drawings.
- J. Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and

options actually being proposed. Cross out non-applicable information. Note specified features such as materials or paint finishes.

- K. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring, piping and service connection data.
- L. Maintain a complete set of reviewed and stamped shop drawings and product data on site.
- M. For each room or area of the building containing electrical equipment, submit the following:
 - 1. Floor Plans: Plan and elevation layout drawings indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than 1/4 inch to 1 foot. They shall be prepared in the following manner:
 - a. Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).
 - b. Illustrate all electrical equipment proposed to be contained therein. Include top and bottom elevations of all electrical equipment. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.
 - c. Illustrate all other equipment therein such as conduits, detectors, luminaries, ducts, registers, pull boxes, wireways, structural elements, etc.
 - d. Indicate the operating weight of each piece of equipment.
 - e. Indicate the heat release from each piece of electrical equipment in terms of BTU per hour. This information shall be that which is supplied by the respective manufacturers.
 - f. Illustrate concrete pads, curbs, etc.
 - g. Indicate dimensions to confirm compliance with code-required clearances.
 - h. Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation).
 - i. Equipment removal routes.
- N. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification

that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.

- O. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superceded in any way by the review of shop drawings, product data and samples.
- P. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.

3.3 COORDINATION OF WORK

- A. The Contract Documents establish scope, materials and quality but are not detailed installation instructions. Drawings are diagrammatic.
- B. Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.
- C. The electrical drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide offsets, fittings, and accessories, which may be required but not shown on the Drawings. Investigate the site, and review drawings of other trades to determine conditions affecting the work and provide such work and accessories as may be required to accommodate such conditions.
- D. The locations of lighting fixtures, outlets, panels and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.
- E. Exercise particular caution with reference to the location of panels, outlets, switches, etc., and have precise and definite locations accepted by the Engineer before proceeding with the installation.
- F. The Drawings show only the general run of raceways and approximate locations of outlets. Any significant changes in location of outlets, cabinets, etc., necessary

in order to meet field conditions shall be brought to the immediate attention of the Engineer for review before such alterations are made. Modifications shall be made at no additional cost to the Owner.

- G. Verify with the Architect the exact location and mounting height of outlets and equipment not dimensionally located on the Drawings prior to installation.
- H. Circuit tags in the form of numbers are used where shown to indicate the circuit designation numbers in electrical panels. Show the actual circuit numbers on the as-built Record Drawings and on the associated typed panelboard directory card. Where circuiting is not indicated, provide required circuiting in accordance with the loading indicated on the Drawings and/or as directed.
- I. The Drawings generally do not indicate the number of wires in conduit for the branch circuit wiring of fixtures and outlets, or the actual circuiting. Provide the correct wire size and quantity as required by the indicated circuiting and/or circuit numbers indicated, the control intent, referenced wiring diagrams (if any), the specified voltage drop or maximum distance limitations, and the applicable requirements of the NEC.
- J. Carefully check space requirements with other trades to ensure that equipment can be installed in the spaces allotted.
- K. Wherever work interconnects with work of other trades, coordinate with other trades to ensure that they have the information necessary so that they may properly install the necessary connections and equipment. Identify items (remote ballast, pull boxes, etc.) requiring access in order that the ceiling trade will know where to install access doors and panels.
- L. Consult with other trades regarding equipment so that, wherever possible, motor controls and distribution equipment are of the same manufacturer.
- M. Furnish and set sleeves for passage of electrical risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each electrical riser passing through building surfaces.
- N. Provide firestopping around all pipes, conduits, ducts, sleeves, etc. which pass through rated walls, partitions and floors.
- O. Provide detailed information on openings and holes required in precast members for electrical work.
- P. Provide required supports and hangers for conduit and equipment, designed so as not to exceed allowable loadings of structures.

- Q. Examine and compare the Contract Documents with the drawings and specifications of other trades and report any discrepancies between them to the Engineer and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- R. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion include a set of these drawings with each set of Record Drawings.
- S. Furnish services of an experienced Superintendent, who shall be in constant charge of all work, and who shall coordinate work with the work of other trades. No work shall be installed before coordinating with other trades.
- T. Coordinate with the local electric utility company and the local telecommunications company as to their requirements for service connections and provide all necessary metering provisions, grounding, materials, equipment, labor, testing, and appurtenances.
- U. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.
- V. Adjust location of conduits, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
 - 1. Right-of-Way: Lines which pitch have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - 2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
- W. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Engineer.

3.4 CONTRACTOR'S COORDINATION DRAWINGS

- A. The Contractor shall coordinate efforts of all trades and shall furnish (in writing, with copies to the Engineer) any information necessary to permit the work of all

trades to be installed satisfactorily and with the least possible interference or delay.

- B. The Contractor and all trade contractors shall prepare a complete set of construction Coordination Drawings indicating the equipment actually purchased and the exact routing for all lines such as busway, conduit, piping, ductwork, etc., including conduit embedded in concrete floors and walls. The Coordination Drawings shall be submitted complete to the Architect and the Engineer, within three months after notice to proceed is given, and in compliance with the construction schedule for the project. The sheet metal drawings, at a scale of not less than 1/4 inch to 1 foot, shall serve as the base drawings to which all other Contractors shall add their work. Each separate trade contractor shall draw their work on separate layers with different color assignments to facilitate coordination. Each Coordination Drawing shall be completed and signed off by the other Trade Contractors and the Contractor prior to the installation of the HVAC, plumbing, electrical and fire sprinkler work in the area covered by the specific drawing. The Contractor's work shall be installed according to the shop drawings and coordination drawings. If the Contractor allows one trade to install their work before coordination with the work of other trades, the Contractor shall make all necessary changes to correct the condition at no additional cost to the Owner.
- C. The Contractors' Coordination Drawings shall indicate structural loads at support points for all piping 10 inch and larger, racked piping, racked conduit, busway, and suspended electrical equipment. Submit to Structural Engineer for review and approval. The elevation, location, support points, static, dynamic and expansion forces and loads imposed on the structure at support and anchor points shall be indicated. All beam penetrations and slab penetrations shall be indicated and sized and shall be coordinated. Work routed underground or embedded in concrete shall be indicated by dimension to column and building lines and shall be coordinated. Coordination Drawings shall document all required structural penetrations for initial construction. Penetrations shall be dimensioned for walls, floors and roofs. These structural coordination requirements require review and approval by the Structural Engineer prior to completion and submittal of the Drawings.
- D. This requirement for Coordination Drawings shall not be construed as authorization for the Contractor or trade contractors to make any unauthorized changes to the Contract Documents. Contract document space allocations shall be maintained such as ceiling height, designated clearance for future construction and flexibility, chase walls, equipment room size, unless prior written authorization is received from the Engineer to change them.

- E. Prior to final acceptance of the Work, the Contractor shall submit the Coordination Drawings as part of the Record Drawings submittal.

3.5 EXAMINATION OF SITE

- A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.
- B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work. Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for the satisfactory completion of the work.

3.6 EXCAVATION AND BACKFILL

- A. Provide excavation for the work of this Division. Excavate all material encountered, to the depths indicated on the Drawings or as required. Remove from the site excavated materials not required or suitable for backfill. Provide grading as may be necessary to prevent surface water from flowing into trenches or other excavations. Remove any water, which accumulates. Provide sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel.
- B. Provide trenches of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum overdepth of four inches below the trench depths indicated on the Drawings or required. Backfill overdepths in the rock excavation and unauthorized overdepths with loose, granular, moist earth, thoroughly machine-tamped to a compaction level of at least 95 percent to standard proctor density or 75 percent relative density or as specified by the Engineer. Whenever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.

- C. Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade, whichever is lower, unless otherwise specifically shown:
 - 1. Electric service: Three (3) feet minimum.
 - 2. Telephone service: Three (3) feet minimum.
 - 3. Cable TV service: Three (3) feet minimum
- D. Trenches should not be placed within ten feet of foundation or soil surfaces, which must resist horizontal forces.
- E. Do not backfill trenches until all required tests have been performed and installation observed by the Engineer. Comply with the requirements of other sections of the Specifications. Backfill shall consist of non-expensive soil with limited porosity. Deposit in six layers and thoroughly and carefully tamp until the work has a cover of not less than one foot. Backfill and tamp remainder of trench at one-foot intervals until complete. Uniformly grade the finished surface.

3.7 CUTTING AND PATCHING

- A. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, lay out the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc., using skilled tradespeople of the trades required at no additional cost to the Owner.
- B. Do not cut, channel, chase or drill unfinished masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
- C. Where conduit or equipment are mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
- D. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.

3.8 MOUNTING HEIGHTS

- A. Mounting heights shall conform to ADA requirements.
- B. Verify exact locations and mounting heights with the Architect before installation.

- C. Electrical and telecommunications outlets shall be mounted no higher than 48 inches above finished floor to top of the outlet box and no lower than 15 inches above finished floor to bottom of the outlet box.
- D. Electrical switches shall be mounted no higher than 48 inches above finished floor to top of the outlet box and no lower than 36 inches above finished floor to bottom of the outlet box.
- E. Fire alarm manual pull stations shall be mounted no higher than 48 inches above finished floor to top of the outlet box and no lower than 36 inches above finished floor to bottom of the outlet box.
- F. Outlets for public and other wall-mounted type telephones shall be installed so that the particular telephone installed conforms to ADA mounting height requirements.
- G. Visual Alarms: Mount not less than 80 inches to the bottom or 96 inches to the top of the device.
- H. Wall-Mounted Exit Signs: Two inches above top of door to bottom of sign.
- I. Low-Level Exit Signs: Six inches to bottom of sign.
- J. Stairwell and utility corridor wall-mounted lighting fixtures shall be mounted 8 feet-6 inches above finished floor or one foot below ceiling or structure above, whichever is lower.

3.9 CLEANING UP

- A. Avoid accumulation of debris, boxes, loose materials, crates, etc., resulting from the installation of this work. Remove from the premises each day all debris, boxes, etc., and keep the premises clean and free of dust and debris.
- B. Clean all fixtures and equipment at the completion of the project. Wipe clean exposed lighting fixture reflectors and trim pieces with a non-abrasive cloth just prior to occupancy.
- C. All electrical equipment shall be thoroughly vacuumed and wiped clean prior to energization and at the completion of the project. Equipment shall be opened for observation by the Engineer as required.

3.10 WATERPROOFING

- A. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
- B. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.

3.11 SUPPORTS

- A. Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.
- B. Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and mechanical equipment rooms.
- C. Provide supporting frames or racks for equipment which is to be installed in a freestanding position.
- D. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.
- E. Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on electric conduits, raceways, or cables for support.
- F. Electrical equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling). Provide independent support of electrical equipment. Do not attach to supports provided for ductwork, piping or work of other trades.
- G. Provide required supports and hangers for conduit, equipment, etc., so that loading will not exceed allowable loadings of structure. Electrical equipment and supports shall not come in contact with work of other trades.

3.12 FASTENINGS

- A. Fasten equipment to building structure in accordance with the best industry practice.
- B. Where weight applied to building attachment points is 100 pounds or less, conform to the following as a minimum:
 - 1. Wood: Wood screws.
 - 2. Concrete and solid masonry: Bolts and expansion shields.
 - 3. Hollow construction: Toggle bolts.
 - 4. Solid metal: Machine screws in tapped holes or with welded studs.
 - 5. Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.
- C. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:
 - 1. At concrete slabs provide 24-inch by 24-inch by 1/2-inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
 - 2. At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with their decking or sub-floor, such hangers shall be provided.
- D. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Engineer and conform to the following as a minimum:
 - 1. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
- E. For items, which are shown, as being ceiling-mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
- F. Wall-mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel

angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.

3.13 IDENTIFICATION

- A. Identify electrical equipment with permanently attached black phenolic nameplates with 1/2-inch high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates for equipment connected to the emergency power system shall be red with white lettering. Nameplates shall be attached with cadmium-plated screws; peel-and-stick tape or glue-on type nameplates are not allowed.
- B. Cable tags shall be flameproof secured with flameproof non-metallic cord.
- C. Provide an engraved nameplate for each switch controlling loads, which are not local to the switch.
- D. Wherever raceways for future use are terminated outside of the building, stake the location with a 2-foot long, 1-inch by 1-inch clear heart redwood stake.
- E. See individual Sections for additional identification requirements.

3.14 PROHIBITED LABELS AND IDENTIFICATIONS

- A. In all public areas, the inclusion or installation of any equipment or assembly which bears on any exposed surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited, unless otherwise approved by Owner.
- B. Required UL labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

3.15 EQUIPMENT PADS AND ANCHOR BOLTS

- A. Provide concrete pads under all floor-mounted electrical equipment. Equipment pads shall conform to the shape of the piece of equipment it serves with a minimum 1-inch margin around the equipment and supports. Pads shall be a minimum of 4 inches high and made of a minimum 28 day, 2500 psi concrete reinforced with 6-inch by 6-inch 6/6 gauge welded wire mesh. Trowel tops and sides of pad to smooth finishes, equal to those of the floors, with all external corners bullnosed to a 3/4-inch radius.

- B. Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.
- C. Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an alternative, the mounting screws may pass through the gypsum board and be securely attached to 6 inches square, 18 gauge galvanized metal backplates, which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not allowed.

3.16 DELIVERY, DRAYAGE AND HAULING

- A. Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time that it is required, the Contractor shall be responsible for its proper storage and protection until the time it is required. Pay for all costs of drayage or storage.
- B. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, the Contractor shall be responsible for resulting disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime costs, etc., at no additional cost to the Owner.

3.17 EQUIPMENT AND MATERIAL PROTECTION

- A. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damaged caused without additional cost to the Owner.
- B. Take responsibility for work, materials, and equipment until finally inspected, tested and accepted. Protect work against theft, injury, or damage, and carefully store material and equipment received on site, which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc. Store equipment to moisture damage in dry, heated spaces.

- C. Provided adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry. Do not install damaged items; take immediate steps to obtain replacement or repair.

3.18 TESTING OF ELECTRICAL SYSTEMS

- A. Comply with the project construction schedule for the date of final performance and acceptance testing, and complete work sufficiently in advance of the Contract completion date to permit the execution of the testing prior to occupancy and Contract close-out. Complete any adjustments and/or alterations, which the final acceptance tests indicate as necessary for the proper functioning of all equipment prior to the completion date. See individual Sections for extent of testing required.
- B. Provide a detailed schedule of completion indicating when each system is to be completed and outlining when field testing will be performed. Submit completion schedule for review within six months after the notice to proceed by Owner's Representative has been given. Update this schedule periodically as the project progresses.

3.19 OPERATING INSTRUCTIONS

- A. Provide the services of factory-trained specialists to provide an operating instructions seminar for equipment and systems. The seminar shall be conducted over a five-day (consecutive) period. Instruction time is defined as straight time working hours and does not include nights, weekends, or travel time to and from the project.
- B. Submit seminar agenda, schedule and list of representatives to the Owner for approval 30 days prior to suggested date of seminar. Do not commence seminar until the Owner has issued a written acceptance of the starting time and attendees. Confirm attendance of seminar by written notification to participants.
- C. Instruct Owner's operating personnel in proper starting sequences, operation, shut-down, general maintenance and preventative maintenance procedures, including normal and emergency procedures.
- D. Submit final copies of Record Drawings and Operating and Maintenance Manuals to Owner at seminar.

- E. Submit a written record of minutes and attendees of the seminar to the Owner.

3.20 OPERATING AND MAINTENANCE MANUALS

- A. Provide Operating and Maintenance Manuals for equipment and materials furnished under this Division.
- B. Submit three final copies of Operating and Maintenance Manuals for review at least ten weeks before the completion date. Assemble data in a completely indexed volume or volumes in three-ring binders and identify the size, model, and features indicated for each item. Print the project name on the outside of the binders.
- C. Maintenance manuals shall include complete cleaning and servicing data compiled in a clear and easily understandable format. Show model numbers of each piece of equipment, complete lists of replacement parts, capacity ratings, and actual loads.
- D. Provide the following information where applicable:
 - 1. Identifying name and mark number
 - 2. Locations (where several similar items are used, provide a list)
 - 3. Complete nameplate data
 - 4. Certified Record Drawings and Final Reviewed submittals
 - 5. Parts list
 - 6. Performance curves and data
 - 7. Wiring diagrams
 - 8. Manufacturer's recommended operating and maintenance instructions with all non-applicable information deleted
 - 9. List of spare parts recommended for normal service requirements
 - 10. Assembly and disassembly instructions with exploded-view drawings where necessary
 - 11. Test reports
 - 12. Trouble shooting diagnostic instructions, where applicable

3.21 RECORD DRAWINGS

- A. The Contractor shall maintain on a daily basis at the Project site a complete set of Record Drawings. The Record Drawings shall initially consist of a set of construction drawings or AutoCAD files of the Contractor's Coordination Drawings. The prints shall be marked or the AutoCAD files electronically updated to show the precise location of all buried or concealed work and equipment, including embedded conduit, raceways and boxes, and all changes and

deviations in the Electrical work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without definite written instructions from the Architect or Engineer. The updated Coordination Drawings shall be used to produce the final Record Drawings that shall be delivered to the Owner in AutoCAD electronic format and full-size hard copy format upon Project completion.

- B. Record dimensions clearly and accurately to delineate the work as installed. Suitably identify locations of all equipment by at least two dimensions to permanent structures.
- C. The Contractor and Subcontractor shall mark all in-progress Record Drawings on the front lower right hand corner with a rubber stamp impression or an AutoCAD image similar to the following:

RECORD DRAWING
(3/8-inch high letters)

To be used for recording Field Deviations and
Dimensional Data Only
(5/16-inch high letters)

- D. Upon completion of the work, the Contractor and Subcontractor(s) shall certify all Record Drawings on the front lower right hand corner adjacent to the above marking with a rubber stamp impression or an AutoCAD image similar to the following:

RECORD DRAWING
CERTIFIED CORRECT
(3/8-inch high letters)

(Printed Name of General Contractor)
(5/16-inch high letters)

Date: _____

(Printed Name of Subcontractor)
(5/16-inch high letters)

Date: _____

- E. Prior to final acceptance of the Work of this Division, the Contractor shall submit properly certified Record Drawings to the Architect and Engineer for review and shall make changes, corrections, or additions as the Architect and/or Engineer may require to the Record Drawings. After the Architect's and Engineer's review, and any required Contractor revisions, the Record Drawings shall be delivered to the Owner on electronic media in AutoCAD format. The Architect and Engineer do not assume any responsibility for the accuracy or completeness of the Record Drawings.

3.22 FINAL PUNCHLIST

- A. Prior to the Final Punchlist, certify that systems and equipment are complete, operational, and are in compliance with the Contract Documents.
- B. During the Final Punchlist, provide personnel with access keys, hand held radios, and necessary expertise to operate each system and piece of equipment to demonstrate operational compliance with the Contract Documents.
- C. Any deficiencies noted on the Final Punchlist shall be expeditiously corrected and certified in writing.

END OF SECTION 260500

SECTION 260501 - ELECTRICAL MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Basic electrical materials and installation. Limited scope general construction materials and methods for application with electrical installations, applicable to all Division 26 work, are also included.
- B. Applicability: Section applies to all Division 26 work, and also to Divisions 27 & 28 work as applicable.

1.2 INSTALLATION - GENERAL

- A. Use of Drawings and Field Conditions: The drawings are diagrammatic, unless detailed dimensioned drawings are included, and show only approximate locations of equipment, fixtures, panelboards, conduits, and wiring devices. Exact locations are subject to the approval of the Owner's Representative. The general run of electrical feeders, branch circuits, and conduits/raceways indicated on the drawings is not intended to be the exact routing. Field route conduits and raceways to suit job conditions.
- B. Installation and Measurements: Make measurements at the site and in the building during construction for all systems installed, as the work progresses, in such a manner that equipment, piping, ducts, conduits/raceways and boxes will fit in the space available. Maintain minimum 7'-6" headroom wherever possible, and in unfinished areas, install electrical equipment and conduits/raceways neatly and as obscure and "out-of-the-way" as physically possible.
- C. Coordination: Where more than one trade is involved in an area, space or chase, cooperate with the other trades and install work to utilize the space equally in proportion to their individual trade requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping, and then electrical conduits and raceways. If, after installation of any equipment, piping, ducts, conduits/raceways, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and /or furnish other equipment as required for adequate space.
- D. Field Changes: If changes in the size or location of the material or equipment supplied is necessary in order to meet field conditions or to avoid conflicts between trades, bring such matters to the immediate attention of the Architect/Engineer and gain approval before proceeding with such alterations.

1.3 QUALITY ASSURANCE

- A. General: Install electrical equipment in a neat and workmanlike manner. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Architect/Engineer.
- B. Equipment and Materials: Of the quality and manufacture specified. Equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc., correspond to the nomenclature dictated by those manufacturers. Where "or equal" is stated, equipment shall be equal in every way to that of the equipment specified and is subject to approval. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's descriptive literature and any other information necessary to indicate compliance with the specified requirements Submit product data for the following:
 - 1. Raceways.
 - 2. Outlet, Pull and Junction Boxes.
 - 3. Conductors.
 - 4. Type "MC" Cable.
 - 5. Wiring Devices and Coverplates.
 - 6. Safety Switches.
 - 7. Panelboards and Circuit Breakers.
 - 8. Lighting Fixtures.
 - 9. Driver Cabinets (include Factory Shop Drawings as well).

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. General: All raceways shall meet applicable NEMA standards and be UL-Listed with each length so labeled.
- B. Acceptable Manufacturers- Metallic Raceways: American Flexible Conduit Company; Republic Conduit; Allied Tube and Conduit; Wheatland Tube Company.
- C. Acceptable Manufacturers- Rigid Non-Metallic Conduits: Cantex; Carlon; National Pipe and Plastics; Queen City Plastics, PW Eagle.
- D. Rigid Metal Conduit: Manufactured from mild steel, hot-dipped galvanized inside and out including threads, conforming to ANAI C80.1 and UL-6.

- E. Electrical Metallic Tubing: Manufactured from mild steel, hot dipped galvanized inside and out, conforming to ANSI C80.3 and UL-797.
- F. Flexible Metal Conduit: Constructed in one continuous length of electro-galvanized, spirally wound steel strip with interlocking convolutions and interior surfaces free from burrs and sharp edges, conforming to UL-1.
- G. Liquid-Tight Flexible Metal Conduit: Same as flexible metal conduit, with extruded liquid-tight PVC jacket, and conforming to UL-360.
- H. Rigid Non-Metallic Conduit: Schedule 40 heavy wall and Schedule 80 extra-heavy wall 90oC, PVC rigid plastic conduit, conforming to ASTM F-512, NEMA TC-2 and UL-651.
- I. Metal Conduit Fittings:
 - 1. UL-listed for the intended application, steel or malleable iron, conforming to ANSI/NEMSA FB-1. Fittings for rigid metal conduit shall be fully threaded. Connectors 1 -inch size and smaller to include insulated throat. Connectors larger than 1-inch size to include plastic insulating bushing.
 - 2. Do Not Use: Die-cast, pressure cast or set-screw type fittings.
 - 3. Acceptable Manufacturers: O.Z Gedney; Steel City; Thomas & Betts; Crouse-Hinds.
 - 4. Non-Metallic Conduit Fittings: Solvent cemented, compatible with specified rigid non-metallic conduit. Acceptable Manufacturers: Same as for Rigid Non-Metallic Conduits.
- J. Wireways:
 - 1. General: UL listed, sheet steel construction with gray baked enamel finish, NEMA-1 for indoor dry locations, other NEMA types as required to suit the application, and supplied in standard sectional lengths. Include snap-in wire retaining spring clips where necessary to hold conductor in place.
 - 2. Size: Cross section per NEC or as indicated.
 - 3. Covers: Screw on type, unless indicated otherwise.
 - 4. Fittings and Accessories: Elbows, tees, pull boxes, hangers, reducers, supports, hardware, etc. as required for a complete installation.
 - 5. Acceptable Manufacturers: Square D; Hoffman; Meco.

2.2 BOXES

- A. Outlet Boxes:
 - 1. Type: Non-gangable galvanized steel, with square cornered tile (or masonry) type extension rings or covers.
 - 2. Minimum Box Size: As required by the NEC, but minimum 4" square or two-gang masonry box, and minimum 2" deep unless restricted by the surroundings.

3. Mounting: Boxes and associated fittings, plates and devices shall be mechanically fastened (screwed). Friction fitting not acceptable.
4. Outlet Boxes Exposed to Moisture, Exterior, Wet or Damp Locations: Cadmium cast alloy or malleable iron, complete with external threaded hubs and gasketed screw fastened covers. Boxes shall be approved for the environmental condition where they will be installed.
5. Acceptable Manufacturers: Steel City; Raco; Appleton; Crouse Hinds.

B. Junction and Pull Boxes:

1. Sized per NEC.
2. General (Dry Location) Use: Minimum 14-gauge galvanized steel with trim for flush or surface mounting as applicable, and screw-on type covers.
3. Damp and Wet Location Use: Raintight construction with gasketed cover and threaded conduit hubs. Boxes shall be approved for the environmental condition of the location where they will be installed.
4. Acceptable Manufacturers: Hoffman; Keystone.

2.3 RACEWAY STRIPS

A. General:

1. Types: As specified and indicated.
2. Finish: Baked enamel, ivory color.
3. Accessories: All fittings, plates, adapters, extension covers, oversize boxes, hardware, etc. as required for a complete installation.

B. Type "X" Raceway Strips:

1. Description: Low profile, one-piece .040" thick galvanized steel surface raceway consisting of factory assembled base and cover section, designed for pulling in conductors.
2. Finish: Ivory, unless indicated otherwise.
3. Acceptable Manufacturers: Wiremold #200, 500, 700, 2000 Series.

2.4 CONDUCTORS (BUILDING WIRE)

- A. Description: 600 volts class, in standard AWG and kcmil sizes. Conductors shall be 98 percent uncoated copper, with heat and moisture resistant type THHN/THWN-2 insulation.
- B. Size: As indicated and per NEC, and minimum #12 AWG except smaller sizes may be used for control circuits, and communications and special systems (see respective specification sections).

- C. Stranding: Conductors size #14 through #10 AWG may be solid or stranded. Conductors sizes #8 AWG and larger to be Class B stranded. Conductors sizes #16 AWG and smaller shall be solid single strand.
- D. Labeling: For full length of conductor, indicating UL seal, manufacturer's name, wire size and insulation type.
- E. Insulation Colors: Color impregnated insulation, in colors to meet color coding requirements in Part 3.
- F. Acceptable Manufacturers: General Cable; Southwire; Cerro Wire.

2.5 TYPE "MC" CABLE

- A. Note: Use only where permitted in PART 3 below.
- B. General: Factory-assembled multi-conductor cable with individually insulated conductors, including a separate equipment grounding conductor, enclosed in a metallic sheath, conforming to UL-1569.
- C. Fire Rating: Three-hour, per UL-1479, for walls and floor-ceiling assemblies.
- D. Plenum Rated: For use in air-handling spaces per NEC 300.22(C).
- E. Conductors: Solid copper, type THHN insulation, 90oC.
- F. Conductor Color Code: Same as for individual building wire.
- G. Wire Sizes Permitted: #12 AWG through #10 AWG.
- H. Metallic Sheath: Interlocked galvanized steel armor with green stripe.
- I. Metal Sheath Grounding: #16 AWG integral bond wire/armor combination per NEC 250.118 (8).
- J. Fittings: UL-listed, conforming to ANSI/NEMA FB-1, made of steel or malleable iron, and designed specifically for Type "MC" Cable. Do not use die-cast or pressure-cast fittings.
- K. Acceptable Manufacturers (Cable): AFC; General Cable; Southwire.
- L. Acceptable Manufacturers (Fittings): Appleton; Crouse-Hinds; Midwest Electric; O-Z/Gedney; Raco; Steel City; Thomas & Betts.

2.6 CONDUCTOR LUGS AND CONNECTORS

- A. General: UL listed, factory fabricated, designed for respective application, conductor type and size, and rated for continuous operation at the current rating of its respective conductor. Compression fittings to utilize industry standard crimping tools and dies.
- B. Acceptable Manufacturers: Amp; Burndy, Ilco; Ideal; O.Z/Gedney; 3M; Thomas & Betts.
- C. Connectors (#10 AWG and Smaller): Nylon shell insulated spiral steel spring type screw-on connectors.
- D. Terminations (#10 AWG and Smaller, Stranded): Nylon insulated crimp ring or fork type connectors for connecting conductors to screw terminals.
- E. Connectors (#8 AWG and Larger): Compression type, with molded plastic insulators.
- F. Lugs (#8 AWG and Larger): Compression type.

2.7 WIRING DEVICES AND COVERPLATES

- A. General: Specification grade as a minimum, unless otherwise specifically indicated
- B. Device Color: Black for all devices and coverplates in the Whitney Auditorium, Stage, Catwalk, Control Booth and adjacent brick walled stairwells and corridors involved in the Project (confirm with Architect).
- C. Acceptable Manufacturers: Hubbell; Pass and Seymour (Legrand); Leviton.
- D. General Use Switches: 20 amp, 120-277 volt, toggle type, quiet operation, quick make-quick break, side/back wired, with nylon or polycarbonate toggle, self-grounding mounting screw clip plate (not staple), ground terminal and silver alloy contacts.
Acceptable Manufacturers: Hubbell #HBL1221, P&S #PS20AC1 or Leviton #1221-2 series.
 - 1. Types: Single-pole, two-pole, three-way, four-way, illuminated handle, keyed, etc. as indicated.
- E. General Use Receptacles: NEMA 5-20R, duplex, 20A, 125V, side/back wired, #14 to #10 AWG screw terminals, nylon face, indented brass contacts for three point connection, self-grounding mounting screw clip plate (not staple). Acceptable Manufacturers: Hubbell #5362B, P&S #5362 or Leviton #5362-S series.
- F. Ground Fault Circuit Interrupting (GFCI) Receptacles: "Decorator" style, NEMA 5-20R configuration, 20 amp, 125 volt A.C., duplex type, ground fault circuit interrupter type, feed-through, specification grade, with test and reset buttons, complying with latest UL requirements. Receptacle to be of high-impact thermoplastic construction, with button colors to match face, and red trip indicator light. Receptacle to include diagnostic indication for mis-wiring, to exceed UL943 voltage surge requirements, and to disconnect

power to receptacle if ground fault protection is lost. Ground fault sensing to be Class A, 5 +/- 1 mA trip level, 0.025 seconds trip time. Acceptable Manufacturers: Hubbell #GFTWRST20, P&S #2097TR, or Leviton #GFTR2 series.

- G. USB (A&C) Receptacles: Leviton #T5833 series, or approved equal by Hubbell or P&S.
- H. GFCI/USB (A&C) Receptacles: Leviton #GUAC2 series or approved equal by Hubbell or P&S.
- I. Special Receptacles: As indicated on the drawings by ratings and/or NEMA configuration. For each special receptacle on the Project, furnish a matching 6' to 10' long (as required) cord and plug set, and connect to respective equipment, unless respective equipment is furnished with same.
- J. Coverplates (Interior Devices): Nylon, with rounded corners and color matching screws, with number of gangs and openings to suit the number and type of wiring devices. Acceptable Manufacturers: Hubbell; Pass and Seymour; Leviton.
- K. Coverplates- Surface Mounted Boxes: Galvanized steel, rounded raised, and painted Black.
- L. Weatherproof Receptacle Coverplates: Weatherproof, cast aluminum with hinged and neoprene gasketed stay-open while-in-use cover and stainless-steel hardware. Acceptable Manufacturer: Steel City or approved equal.

2.8 EQUIPMENT CONNECTIONS

- A. General: Materials as specified in this Section, and as indicated or required.

2.9 HANGERS AND SUPPORTS

- A. Materials and Design: All hangers, supports, fasteners and hardware shall be zinc-coated or equivalent corrosion resistance by treatment or inherent property, and shall be manufactured products designed for the intended application. Products for outdoor use shall be hot dipped galvanized.
- B. Types: Hangers, straps, riser supports, clamps, U-channel support systems, threaded rods, etc. as indicated and required.
- C. U-Channel Supports: Steel with electroplated zinc finish for interior dry locations. Wet location and exterior channel support systems shall be steel with hot dipped galvanized finish and stainless-steel hardware as a minimum. Cut ends shall be touched up with suitable matching finish. Provide all necessary accessories including bolts, screws, anchors, connection plates, and straps as required for a complete installation.

- D. Acceptable Manufacturers: Unistrut; Globe; Kindorf; B-Line.

2.10 ELECTRICAL IDENTIFICATION

- A. Nameplates: Three-layer laminated plastic with minimum 3/16" high white engraved characters on black background, and punched for mechanical fastening. Fasteners to be self-tapping stainless-steel screws or number 10-32 stainless steel machine screws with nuts and flat and lock washers.
- B. Marking Pens: Permanent, waterproof, quick drying, black ink. Acceptable Manufacturers: Sanford's No. 3000 "Sharpie", or equal.
- C. Wire Tags: Vinyl or vinyl cloth self-adhesive wraparound type, indicating appropriate circuit number, etc.
- D. Wiring Device Circuit Labels: Machine prepared adhesive label tapes, indelible white ink on clear background. Size so as to be easily legible (3/16" high characters), and consistent throughout.
- E. HVAC Equipment Circuit Labels: Machine prepared adhesive label tapes, indelible black ink on white background. Size so as to be easily legible, and consistent throughout.
- F. Panelboard Circuit Directories: Manufacturer's standard cards.

2.11 GROUNDING

- A. Conductors: As specified elsewhere in this section, and as indicated.
- B. Clamps and Pressure Connectors: Cast copper, copper alloy, or bronze alloy, suitable for use with aluminum and copper. Double-bolt type with formed shoe and "U" cable clamp for connection to pipe or conduit; single-bolt type with cable shoe and "U" cable clamp for connections to flat bar or metal; and double-bolt, parallel conductor split clamp type for cable to cable connections.

2.12 SAFETY SWITCHES

- A. General: NEMA heavy duty, horsepower rated, fully enclosed, fusible (with rejection fuse clips) or non-fused as indicated, quick-make, quick-break switching mechanism interlocked with cover, and NEMA-1 (indoors) or NEMA-3R (outdoors) enclosure unless indicated otherwise.
- B. Ratings and Poles: Provide switches with ratings and number of poles as indicated (or as required to suit load if ratings are not indicated).

- C. Solid Neutral: Include for all switches where neutral conductor is present.
- D. Equipment Ground: Include equipment ground kit for each switch.
- E. Acceptable Manufacturers: ABB/General Electric; Eaton; Schneider Electric/Square D.

2.13 PANELBOARDS AND CIRCUIT BREAKERS

- A. General: Ratings, mains, mounting and complement of branch overcurrent protective devices as indicated below or on the Drawings.
- B. Type: Two-row circuit breaker branch circuit and distribution panelboards.
- C. Short Circuit Ratings: Minimum 10,000 amps (120/208 volt panelboards) and 14,000 amps (277/480 volt panelboards). Provide panelboards with higher ratings as indicated.
- D. Enclosures: NEMA-1 unless indicated otherwise, code gauge galvanized steel rough-in box and dead front, sheet steel cover with gray enamel finish, latch and lock. Include plastic covered circuit directory card and holder.
- E. Bussing: Copper. Include ground bus, bonded to enclosure.
- F. Circuit Breakers: Bolt-in, molded case with thermal and magnetic trips unless indicated otherwise. Minimum RMS symmetrical interrupting capacities of 10,000 amps for all breakers in 120/208 volt panelboards, and 14,000 amps for all breakers in 277/480 volt panelboards. Provide breakers with higher ratings where indicated or necessary to meet required panelboard short circuit ratings. Lower rated overcurrent protective devices based on series ratings with upstream devices will not be acceptable.
 - 1. "HACR" Rating: All circuit breakers serving air conditioning equipment (e.g. condensing units and roof top units) to be "HACR" rated.
- G. Order of Branch Breakers: Branch circuit panelboard breakers to be arranged in order as indicated in the panelboard schedules.
- H. Individual Enclosed Circuit Breakers: Provide individual enclosed circuit breakers with NEMA-1 enclosure (unless indicated otherwise), with ratings and features as indicated.
- I. Acceptable Manufacturers:
 - 1. Branch Circuit Panelboards: ABB/General Electric "A" series; Eaton "Pow-R-Line C" series; Schneider Electric/Square D "NQOD" series.
- J. Panelboard Schedules: Refer to the panelboard schedules on the Drawings.

- K. Circuit Breakers to Be Added to Existing Panels: Ampere ratings as indicated. Match existing manufacturer (or compatible), and voltage and interrupting ratings.

2.14 LIGHTING FIXTURES

- A. General: Fixture types as described in the Lighting Fixture Schedule (see below). Lighting fixture manufacturers' series or catalog numbers listed indicate general quality, type, and style, but may not cover any or all required design details or options. Provide lighting fixtures having features, details and accessories as noted in the fixture descriptions and in this specification section. Provide all fittings, hangers, clamps, brackets, yokes, flanges and miscellaneous devices required for a complete installation.
- B. Mounting: Confirm ceiling type and associated mounting requirements for each fixture type with the Architect, prior to preparing submittals.
- C. LED Lamps and Drivers: As scheduled in the Lighting Fixture Schedule (see below). Drivers to include 0-10 VDC dimming, range specified, unless indicated otherwise.
- D. Lighting Fixture Schedule: See notes on Drawings, and/or Section 265001 Lighting Fixture Schedule (if applicable).

PART 3 - EXECUTION

3.1 RACEWAYS

- A. General: Install raceways continuous from outlet box to outlet box and from outlet box to cabinet, junction or pull box. Secure and bond each raceway to each associated box and cabinet so that raceway system is electrically continuous throughout.
- B. Sizing: Size raceway as required by the National Electrical Code (minimum) with oversize conduits as indicated and where required for ease of pulling wire or cable.
- C. Minimum Conduit Size: 1/2" unless indicated otherwise. Minimum 3/4" for panelboard homeruns.
- D. Types: Unless indicated otherwise, use raceway types as follows:
 - 1. Indoors, Concealed in Walls or Above Ceilings: EMT.
 - 2. Indoors, Exposed: Use rigid galvanized steel conduit below five feet above finished floor. EMT may be used above five feet.
 - 3. Outdoors, Exposed: Rigid galvanized steel conduit.
 - 4. Flexible Metal Conduit: Use in dry locations only, for connections to vibrating equipment, and equipment requiring minor adjustments in positions, for final

- connections to recessed lighting fixtures, between outlet boxes in stud partitions, and for all final connections to all indoor transformers.
5. Liquid-Tight Flexible Metal Conduit: Use where flexible metal conduit connections are required in damp, wet or oily locations, and for final connection to all motors and motorized equipment.
 6. Wireways: As indicated or required.
- E. Routing: As required by job conditions unless specific routes or dimensioned positions are indicated on the Drawings. Install tight to slabs, beams and joists wherever possible. Minimize bends and offsets as much as practicable. Verify exact locations of all raceways, pull boxes, and junction boxes. Resolve any potential conflicts before commencing installation. Route exposed conduit, and conduit installed above ceilings, parallel or perpendicular to walls, ceilings and structural members. Install to maintain maximum possible headroom and to present a neat appearance.
- F. Installation (General): In accordance with the NEC and NECA's "Standards of Installation". Cut conduit ends square using saw or pipe-cutter and ream each cut end smooth. Bush where necessary. Carefully make all conduit bends and offsets so that the inside diameter of pipe is not reduced. Make bends so that legs are in the same plane. Make offsets so that legs are in the same plane and parallel. Protect stub-ups from damage, and carefully re-bend when necessary.
- G. Fittings: Make up all raceway fittings tight so that final installation of raceway, fittings and enclosures constitutes a firm mechanical assembly and a continuous electrical equipment grounding conductor. Where required, provide bonding jumpers to assure electrical continuity.
- H. Conduit Support Spacings: No greater than allowed by NEC for the respective conduit type. Securely fasten each conduit within 3 feet of each connecting outlet box, junction box, cabinet or fitting.
- I. Protection: Protect and cap all raceways, enclosures and equipment during construction to prevent entry of concrete, mortar, debris and other foreign matter. Free clogged conduits of all obstructions, or replace, prior to pulling wire. Do not pull wire until building is completely enclosed.
- J. Heat Producing Equipment and Hot Surfaces: Maintain not less than 12 inches clearance between all raceways systems and any such equipment/surfaces.
- K. Expansion Joints: Provide expansion fitting for each conduit crossing a building expansion joint so that no undue stress is placed on the conduit due to the proper functioning of the expansion joins.

- L. Penetrations Through Structural Members: If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Architect/Engineer and obtain written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.
 - M. Conduits Passing Through Roof: Where a conduit punctures the roof, install pitch pocket as required in order that the roof warranty is maintained. Coordinate with representative of roofing material manufacturer.
 - N. Flush Mounted Panelboards: At each flush mounted panelboard, terminal cabinet, control cabinet, etc., provide four spare $\frac{3}{4}$ -inch. conduits from panelboard, etc., to an area above the nearest accessible ceiling space. Make 90° turn above the ceiling, arranged for further continuation of raceway, and cap.
 - O. Bushings: Provide a bushing at each conduit termination unless fitting at box where conduit terminates has hubs designed in such a manner to provide equivalent protection to conductors. Provide grounding type insulated bushings on all conduit sizes 1-1/4-inch trade size and larger, and on all feeder raceways regardless of size. Provide standard bushings for conduits 1-inch and smaller.
 - P. Differing Temperatures: For raceways routed between areas with differing temperatures (interior to exterior, etc.) install raceway as follows:
 - Q. Provide a thermal break, 4 in. minimum of stainless steel conduit within space wall/separation.
 - R. Seal raceway penetration through the wall/separation.
 - S. Provide a box on each side of the space wall/separation.
 - T. Provide raceway interior sealant (duct seal or suitable foam) to provide a complete air barrier after conductors are installed.
 - U. Mounting of raceway and boxes on equipment shall be coordinated and approved by the equipment manufacturer.
 - V. Raceways On Wet, Damp or Exterior Walls: Provide spacers to maintain a minimum $\frac{1}{2}$ " space/void between the mounting surface and the raceway.
- 3.2 OUTLET BOXES
- A. Size: As specified and per NEC.
 - B. Locations: Outlet locations shown on Drawings are approximate only. Study architectural, mechanical, plumbing and structural drawings and roughing-in, and note surrounding

areas in which each outlet is to be located. If necessary, adjust outlet location so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet will serve its desired purpose. Where conflicts exist between drawings, contact Architect/Engineer for resolution prior to rough-in.

- C. Location Changes at Architect's Discretion: Prior to rough-in, relocate any outlet up to a distance of five feet in any direction from location indicated on Drawings if so directed by the Architect/Engineer. Prior to completion of wall construction, adjust vertical height of any outlet from height indicated on Drawings if so directed by Architect/Engineer. Make the above modifications at no additional cost to the Owner.
- D. Horizontal Alignment: Where outlets at different mounting heights are indicated on drawings adjacent to each other (due to lack of physical space to show symbols on drawings), install outlets on a common vertical line.
- E. Light Switch Outlets: Where shown adjacent to strike side of a door, locate edge of outlet box approximately three inches from door frame.
- F. Adjoining Rooms: Do not install outlet boxes "back-to-back" in common wall separating two adjacent rooms without the approval of the Architect/Engineer. Do not use through-wall boxes.
- G. Outlet Boxes in Plaster, Gypsum Board or Wood Paneled Hollow Cavity Walls: Install flush using raised tile covers. Mechanically fasten and support from two adjacent structural members (studs) with cross brackets (Garvin Industries Model "BMB" or equal).
- H. Outlet Boxes in Tile, Brick or Concrete Block Walls: Install flush using extra-deep type raised tile covers or use 3-1/2 inch deep boxes with square corners.
- I. Surface Wall Mounted Outlet Boxes: Use cast type boxes.
- J. Outlet Coverplates: Install a device coverplate over each and every outlet indicated on drawings, unless indicated to be provided by others. Provide blank plate for each outlet without an indicated device. Do not install coverplates until painting, cleaning and finishing of surfaces surrounding the outlet are complete.
- K. Multi-Gang Outlets: Install single one-piece multi-gang covers over multi-gang devices.

3.3 JUNCTION AND PULL BOXES

- A. General: Provide as indicated and as useful/necessary to suit field conditions, length of and number of bends per conduit run, and for ease of pulling conductors/cables.
- B. Size: As indicated and per NEC.

- C. Installation: Install all junction and pull boxes rigidly, plumb and level. Support and secure boxes independently from conduits terminating at box. Install boxes so as to be readily accessible and so that covers may be easily removed.

3.4 RACEWAY STRIPS

A. General:

1. Inspection: Examine surfaces to receive raceway strips to make certain they are straight, true, and dry. Report any discrepancies and proceed only when corrected.
2. Installation: Install raceway strips plumb, square and level, centered in spaces and at heights indicated.
3. Complete System: Provide all miscellaneous components, hardware, etc. as required for a complete installation.
4. Grounding: Bond each raceway strip to the conduit system(s) serving the strip, at each service point. Maintain continuity of adjoining sections via grounding jumpers. Ground each receptacle device in each raceway strip using an equipment grounding conductor.

B. Type "X" Raceway Strips:

1. Uses Permitted: In renovation areas only. (May not be used in areas with new wall construction). Use where specifically indicated, and elsewhere only in areas where existing walls are to remain, and there only where existing wall construction makes concealed conduit installation impractical (e.g. solid brick or concrete walls). Obtain prior written approval for each location where surface raceway is to be installed. Exact configurations and routing are subject to the Architect/Engineer's approval.

3.5 WIRING METHODS

- A. General: All wiring systems to be composed of individual 600 volt class wires installed in specified raceway systems, except as follows:
- B. Type "MC" Cable: May be used only in the permitted sizes listed above, and then only for interior branch circuiting concealed in accessible ceiling spaces or in stud partitions. Do not use elsewhere. Do not use anywhere where exposed (e.g. on Whitney Auditorium Stage or in mechanical and electrical equipment rooms, corridors and storage rooms without ceilings, etc.). Comply with installation requirements below.

3.6 CONDUCTOR SIZES AND QUANTITIES

- A. Minimum Conductor Size: All branch circuit wiring shall be minimum #12 AWG. All control circuit wiring shall be minimum #14 AWG. Provide larger sizes as indicated or required for NEC required ampacity derating. All feeders and circuits to be same conductor size for full length of run from source to termination, unless indicated otherwise.
- B. Branch Circuit Conductor Sizes: Provide branch circuit wire sizes as indicated. Neutral wire sizes to match respective phase wire sizes unless indicated otherwise.
- C. Branch Circuit Common Neutrals: (Not permitted).
- D. Combining Homeruns: Do not combine separately indicated homeruns in single conduit unless specifically approved by the Architect/Engineer.
- E. Maximum Number of Conductors in Branch Circuit Raceways: Nine. Upsize conductor sizes for ampacity adjustments as required by 2014 NEC Table 310.15(B)(3)(a).
- F. Switch Legs: Provide branch circuit switch legs and travelers as required for the switching indicated.
- G. Service and Feeders: Provide service and feeder conductor sizes and quantities as indicated. Do not combine more than one feeder into a single conduit.
- H. Equipment Grounding Conductor Required: For each branch circuit and feeder run, provide an equipment grounding conductor, sized per NEC (minimum, larger if so indicated) whether indicated or not.

3.7 CONDUCTOR INSTALLATION

- A. General: Install all conductors, cables and associated items in compliance with all applicable requirements of the NEC, NEMA, UL and NECA's "Standards of Installation", and in accordance with the respective manufacturer's recommendations.
- B. Terminations: Furnish and install terminations, including lugs if necessary, to make all electrical connections indicated or required. Enclose all strands of stranded conductors in connectors and lugs.
- C. Tightening: Tighten all connectors, lugs, screws, bolts, Allen-heads and other electrical fasteners to torque values per manufacturer's written instructions.
- D. Restrictions: Do not substitute smaller conductors with higher temperature rated insulations in lieu of the conductors shown on the Drawings.
- E. Conductor Installation- General: Do not install conductors/cables until respective raceway system, including all outlets, cabinets, bushings and fittings, is completed. Verify that all work of other trades which may cause conductor damage is completed. Use only U.L.

approved cable lubricants when necessary. Do not use mechanical means to pull conductors #8 AWG or smaller.

- F. Phases and Grounds: All wiring systems shall be properly grounded and continuously polarized throughout, following the specified color-coding.
- G. Feeder Connections: Make all feeder connections to bus and other equipment using solderless, pressure type terminal lugs.
- H. Branch Circuit Splices and Taps, #10 AWG and Smaller: Use specified nylon shell insulated spiral steel spring type screw-on connectors.
- I. Splices and Taps, #8 AWG and Larger: Use insulated solderless set-screw AL/CU or hydraulically compressed sleeve fittings suitable for the intended use.
- J. Slack Conductor Lengths: Provide minimum six inches of slack length for each conductor in each junction box, pull box and termination. For branch circuit outlets, leave a minimum of 8 inches free conductor length for connections of devices and fixtures.
- K. Splices and Connections: Make in accessible boxes and cabinets only.
- L. Uninsulated Splices and Free Conductor Ends: Completely insulate with rubber and friction tape, PVC electrical tape, or plastic insulating caps. Heat shrink sleeves are acceptable for crimp and compression type splices.
- M. Feeder Conductors: Install continuous from point of origin to load termination without splice. If this is not practical, contact the Architect/Engineer and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors as nearly equal as possible.
- N. Conductors in Panelboards and Control Panels: Neatly train and bind together using "Ty-Raps" or equal.
- O. Vertical Conduit Runs: Provide cable/conductor support per NEC.
- P. Color Code: Color code all service, feeder and branch circuit wires as follows:
 - 1. 120/208 Volts: Phase A (Black); Phase B (Red); Phase C (Blue), Neutral (White).
 - 2. 277/480 Volts: Phase A (Brown); Phase B (Orange); Phase C (Yellow), Neutral (Gray).
 - 3. Equipment Grounding Conductors: Green.

3.8 TYPE "MC" CABLE INSTALLATION

- A. General: Run cables neatly, primarily parallel and perpendicular to walls, ceilings and structural members, not diagonally. Securely strap cables in place at intervals not exceeding NEC requirements. Run cables neatly together along common routes where possible. Do not droop or lay cables on ceilings, or run loosely through building construction.

3.9 WIRING DEVICES AND COVERPLATES

- A. Switches: Locate switches in accessible locations near room/space entry point(s). Install single-pole and double-pole switches so that the circuit is on when the switch handle is up.
- B. Lighted Handle Switches: Provide lighted handle switches for all light switches in mechanical rooms, electrical rooms, crawl spaces, elevator pits, etc.
- C. Receptacles: Install receptacles with ground pin down when mounted vertically.
- D. GFCI Receptacles: For each receptacle designated or indicated to be "GFCI", provide a GFCI type receptacle. Do not substitute general use receptacle with feed-thru GFCI protection from upstream GFI receptacle.
- E. Coverplates: Provide coverplate for each wiring device or group of devices. Where devices are shown adjacent (e.g. bank of light switches), mount all such adjacent devices under one multi-gang coverplate, unless indicated otherwise.

3.10 EQUIPMENT CONNECTIONS

- A. General: Connect complete, all equipment requiring electrical connections, furnished as part of this Contract or by others, unless indicated otherwise. Confirm exact equipment locations with trade furnishing and installing the respective equipment.
- B. Equipment Variations: Note that equipment sizes and capacities as shown on the Contract Documents are for bidding purposes and as such may not be the exact unit actually furnished. Contractor shall anticipate minor variations in equipment and shall include in his Bid all costs required to properly connect the equipment actually furnished.
- C. Verification: Obtain and review product data, shop drawings, and manufacturer's written installation instructions for equipment furnished by others. Examine actual equipment to verify proper connection locations and requirements.
- D. Coordination: Sequence electrical rough in and final connections to coordinate with the installation and start up schedule and work by other trades.

- E. Rough-In: Provide all required conduit, boxes, fittings, wire, connectors and miscellaneous accessories, etc. as necessary to rough-in and make final connections to all equipment requiring electrical connections.
- F. Motors and Equipment: In general, motors and motorized equipment shall be wired in conduit to a junction box (or safety switch) near the unit, and from there to the unit in liquid-tight flexible metal conduit.
- G. Connections: Provide properly sized overload and short circuit protection for all equipment connected, whether furnished under this Contract or by others. Verify proper connections with manufacturer's published diagrams and comply with same. Report any discrepancies between the Contract Documents and actual equipment requirements. Do not proceed with connections until resolved. Verify that equipment is ready for electrical connections, wiring and energization, prior to performing same.
- H. Control Wiring: Provide all control wiring to remote devices or equipment as indicated or required. Modify equipment control wiring, install or disconnect jumpers, etc. as required for proper operation of equipment.
- I. HVAC and Plumbing Systems Motors: Provide all required power wiring from indicated power source to each motor controller and from each motor controller to respective motor. Make all connections to motors and control equipment complete and leave equipment in proper operating order. Connect power to motors for correct direction of rotation. Verify nameplate ratings of all motors. Report any deviations or discrepancies.

3.11 HANGERS AND SUPPORTS

- A. General: Rigidly support and secure all electrical materials, raceway and equipment to building structure using hangers, channels, supports and fasteners, suitable for the use, materials and loads encountered. Provide all necessary hardware.
- B. Overhead Mounting: Attach overhead mounted equipment to structural framework or supporting metal framework. Do not make attachments to steel roofing, steel flooring or ceiling tiles.
- C. Wall Mounting: Support wall mounted equipment by masonry, concrete block, metal framing or sub-framing.
- D. Exterior Building Walls: Mount all electrical equipment located on the interior of exterior building walls, at least 1/2" away from wall surface, using suitable spacers.
- E. Structural Members: Do not cut, drill or weld any structural member except as specifically approved by the Architect/Engineer.

- F. Independent Support: Do not support electrical materials or equipment from other equipment, ductwork or supports for same.
- G. Raceway Support: Rigidly support all raceway with maximum spacings per NEC, and so as to prevent distortion of alignment during pulling operation. Use approved hangers, clamps and straps for individual raceway runs. Do not use perforated straps or tie wires. Where multiple parallel raceways are run together, use trapeze type hanger arrangement made from U-channel and accessories, suspended by threaded rods, and allow at least 25% spare capacity for future installation of additional raceways. Rigidly anchor vertical conduits serving floor-mounted or "island" type equipment mounted away from walls with metal bracket or rigid steel conduit extension secured to floor.
- H. Miscellaneous Supports: Provide any additional structural support steel brackets, angles, fasteners and hardware as required to adequately support all electrical materials and equipment.

3.12 EQUIPMENT MOUNTING HEIGHTS

- A. General: As indicated.
- B. Where structural or other interferences prevent compliance with mounting heights listed above, consult Architect/Engineer for approval to change location before installation.

3.13 ELECTRICAL IDENTIFICATION

- A. General: Locate nameplate, marking or other identification means on outside of front covers when above ceilings, in equipment rooms, and when in other unfinished areas. Locate on backside of front cover when in finished rooms/areas. Use Contract Document designations for identification legends unless indicated otherwise.
- B. NEC Required Identification: Provide all equipment identification, warning signs, etc. as required by the NEC.
- C. Manufacturer Supplied Equipment Nameplates: Provide equipment nameplates and markings, with all information as required by NEMA and UL.
- D. Nameplates: Provide an engraved nameplate (with minimum height characters indicated) for each of the following:
 - 1. Switchboards, meter centers, distribution panels and motor control centers- (1/2" H). Indicate equipment name and voltage, phases and wires.
 - 2. Overcurrent devices, and all other devices mounted in any of the above - (5/16" H).

3. Branch circuit panelboards, safety switches, motor controllers and drives, individually mounted circuit breakers, transformers, relay enclosures, and miscellaneous electrical cabinets - (5/16" H). Indicate equipment name (or load served) and voltage, phases and wires.
 4. Motor control stations, and toggle switches located remote from load served, or where function is not readily evident - (3/16" H).
 5. Communications and special system cabinets - (5/16" H).
 6. HVAC Equipment and Separately Mounted Switches and Controllers for Same:
For each piece of HVAC equipment and controller, provide label tape indicating respective panelboard and circuit numbers(s) serving the equipment. Locate on each safety switch or controller serving the equipment where applicable, and also on unit itself in location obviously conspicuous to service/operating personnel.
- E. Marking Pen Labeling: Mark each junction and pull box indicating source designation and circuit number(s) for the enclosed conductors.
- F. Wire Tags: Apply wire tag indicating appropriate circuit or feeder number to each conductor present in panelboard gutters, and to each conductor in pull and junction boxes where more than one feeder or multi wire branch circuit is present. Where only a single feeder or multi wire branch circuit is present, box cover labeling and conductor color coding is sufficient. For control, communications and signal circuits, apply wire tag indicating circuit or termination number at all terminations and at all intermediate locations and boxes where more than one circuit is present.
- G. Panelboard Circuit Directories: For each new panelboard and each existing panelboard where any circuit modifications are made, provide and accurately complete a new circuit directory card in typewritten form, identifying load served or "spare" or "space" for each circuit pole space. Use actual Owner designated room numbers or names (not construction room numbers or designations)
- H. Wiring Devices: Using adhesive backed printed tape, label each wiring device coverplate, indicating respective panel designation and circuit number serving the device. Attach tape label to outside of device coverplate.
- 3.14 GROUNDING
- A. General: Provide all system and equipment grounding and bonding as indicated and as required by the NEC.
- B. Equipment Grounding: Provide a green equipment grounding conductor, sized per NEC (larger if so indicated) with each feeder and branch circuit run.

3.15 SAFETY SWITCHES

- A. Mounting: Mount safety switches where indicated, and on wall or column adjacent to unit served, or directly to unit or supporting framework where applicable, indicated or required.
- B. Connections: Make all indicated/required electrical connections.

3.16 PANELBOARDS AND CIRCUIT BREAKERS

- A. General: Secure panelboard rough-in boxes to building structure or steel framing, independent of conduits. Install with top of box per NEC restrictions. Make all indicated and required feeder and branch circuit connections. Neatly train and tie all wiring within panelboard enclosure.
- B. Cover all unused overcurrent protective device spaces.
- C. Removals: Remove existing panelboards as indicated.
- D. Existing Panelboards to Remain: Remove existing breakers, provide new breakers, add/revise circuiting, etc. as indicated and required.

3.17 LIGHTING FIXTURES

- A. General: Install lighting fixtures as described in the Lighting Fixture Schedule, complete with LED or other indicated lamps, and drivers/ballasts. Provide all necessary accessory fittings, hangers, stems, clamps, brackets, yokes, plaster flanges, outlet boxes, and miscellaneous devices required for a complete installation as recommended by the fixture manufacturer.
- B. Quantity: Per Electrical Drawings.
- C. Locations: General locations per Electrical Drawings, exact locations per Architectural reflected ceiling plans, interior and exterior elevations, and details. Architect reserves the right to field direct the exact location for all decorative fixtures in public spaces.
- D. Mounting and Support: Securely support and/or suspend all lighting fixtures from structural members of building.
- E. Mounting Heights: Suspend pendant mounted lighting fixtures at heights indicated, measured from finished floor to bottom of fixture enclosure or reflector unless noted otherwise. Install wall mounted fixtures at heights indicated measured from finished floor to center of fixture outlet box unless noted otherwise.
- F. Recessed Lighting Fixtures: Provide flexible connections to all recessed lighting fixtures as required by the NEC and in accordance with approved wiring methods. Secure fixtures to

the ceiling framing members per NEC. Secure troffers to ceiling tees twice along each long side of troffer.

- G. Lamps: Install specified lamps as recommended by the lamp and lighting fixture manufacturers. Follow lamp manufacturer's recommendations for handling and installing lamps.
- H. Defective LED's, Lamps and Drivers/Ballasts: Replace all burned out, defective and inoperative LED's and lamps, and all noisy, defective and inoperative drivers/ballasts, prior to Owner's acceptance.

3.18 SPARE PARTS

- A. General: Deliver specified spare part to Owner and obtain receipt for spare parts.

3.19 CONDUCTOR TESTS

- A. Branch Circuits: Test during installation for continuity and identification and perform operational tests to determine that all circuits perform the function for which they are intended.
- B. Feeder Conductors: For all feeder conductors rated 600 volts or less, provide "Megger" insulation test prior to energizing, using a 1,000-volt motor driven megger. Apply test voltage until readings reach a constant value, and until three equal readings, each one minute apart, are obtained. Minimum megger reading shall be 45 megohms for feeder conductors. Document test results and submit for approval prior to energizing conductors.

END OF SECTION 260501

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Connectors, splices, and terminations rated 600 V and less.

1.2 DEFINITIONS

- A. PV: Photovoltaic.
- B. RoHS: Restriction of Hazardous Substances.
- C. VFC: Variable-frequency controller.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.
- C. Qualification Data: For testing agency.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- D. Conductor Insulation:
 - 1. Type RHH and Type RHW-2: Comply with UL 44.
 - 2. Type THHN and Type THWN-2: Comply with UL 83.
 - 3. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
 - 4. Type XHHW-2: Comply with UL 44.
 - 5. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
 - a. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent braided shields with full size drain wire, full sized insulated ground wire, and sunlight- and oil-resistant outer PVC jacket. Provide this cable between VFCs and motor loads as indicted on drawings.

2.2 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Comply with UL 1569.
 - 3. RoHS compliant.

- 4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Circuits:
 - 1. Single circuit and multicircuit with color-coded conductors.
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Ground Conductor: Insulated.
- F. Conductor Insulation:
 - 1. Type TFN/THHN/THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.
- G. Armor: Steel or lightweight Aluminum, interlocked.
- H. Jacket: PVC applied over armor (when Specified).

2.3 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2.4 INSULATING TAPE

- A. Provide vinyl plastic tape that meets the requirements of UL 510 and has the following characteristics:
 - 1. 8.5 Mil minim thickness.
 - 2. ASTM D-3005 Standard specification for low-temperature resistant vinyl Chloride plastic pressure-sensitive electrical insulating type – type1.
 - 3. Rated 600 volts and 150°C, suitable for indoor and outdoor applications.
 - 4. Retains flexibility, adhesion, and applicable at temperature ranges from 0 through 100°F without loss of physical or electrical properties.

5. Resistant to abrasion, moisture, alkalis, acid, corrosion, and sunlight
6. Tape manufacturer: 3M "Scotch Super 88" or approved equal.

2.5 MANUFACTURERS

- A. Wire Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):
 1. Southwire Company
 2. General Cable
 3. The Okonite Company
 4. Belden
 5. VitaLink
 6. Pyrotenax
- B. Connectors Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):
 1. Hubbell
 2. Thomas & Betts
 3. 3M Company

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders/Branch circuits: Copper; solid for No. 10 AWG and No. 12 AWG; stranded for No. 8 AWG and larger.
- B. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway; Type XHHW-2, single conductors in raceway; Type USE, single conductor in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.

- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway; Type XHHW-2, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway;
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- I. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- K. VFC Output Circuits: Type XHHW-2 in metal conduit; Type TC-ER cable with dual tape shield.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Contract drawings do not indicate size of branch circuit wiring; use No.12 AWG as a minimum wire size for branch circuit wiring. For 20 Ampere branch circuits whose length from the panel to the furthest outlet exceeds 100 feet for 120-volt circuits or 150 feet for 277-volt circuits; use No. 10 AWG or larger for the entire branch circuit installation.
- C. A shared neutral may be utilized for circuits other than circuits used for dimmers, ground fault interrupter receptacles or circuit breakers, isolated ground receptacles, and isolated ground surge suppressor type devices
- D. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

- E. 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.
- F. Do not install wire in incomplete conduit runs nor until after concrete work and plastering is completed and moisture is swabbed from the conduits. Eliminate splices where possible. Where necessary, splice in readily accessible pull, junction or outlet box.
- G. Take precautions to avoid entrance of dirt and water into the conduit and cuts. Clean conduits and ducts to remove and pulling compound prior to pulling cables. Do not damage conductor insulation, braid jacket or sheath during installation. Any damaged conductors shall be replaced immediately.
- H. Use pulling means, including fish tape, cable, rope, cable reels on jacks, and basket-weave wire/cable grips, that will not damage cables or raceway. Do not exceed maximum recommended pulling tension of wire and cable
- I. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- J. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Except where lugs are furnished with equipment, make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Circumferential compression type connector (provide for splices and connections No. 6 AWG and larger):
 - 1. Use for incoming and outgoing cable connections at enclosures and for ground connections.
 - 2. Use manufacturer's approved tool and correct size hex head with embossed die number on the connector or lug.
 - 3. Make crimped indentions parallel with insulation putty.
 - 4. Fill voids and irregularities with insulation putty.

5. Cover nearly with four (4) layers of vinyl plastic tape except where insulated covers are permitted; half-lap tape in two (2) directions.

- D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to the project specifications.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:
 3. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line/riser diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
 - i. Insulation resistance to comply with ICEA values.
 4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- E. Cables will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete grounding system in accordance with the Contract Documents and as specified herein.

1.2 SUBMITTALS

- A. Minimum 1/8" scale floor plan drawings depicting the building ground electrode system as to be installed.
- B. Detailed riser diagram depicting the building ground electrode system and bonding as to be installed.
- C. Product data sheets (cut sheets) for all ground bus bars and other components of the grounding system.
- D. Field test reports.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 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 and shall be Lexan or PVC, impulse tested at 5000 V.

2.3 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. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- I. Lay-in Lug Connector: Mechanical type, aluminum or copper rated for direct burial terminal with set screw.

- J. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- K. Straps: Solid copper, cast-bronze clamp or copper lugs. Rated for 600 A.
- L. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.
- M. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- N. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with stainless-steel bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.
- B. Ground Plates: 1/4-inch-thick, hot-dip galvanized.

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. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, 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; connect to horizontal bus.

E. 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 AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.
- B. At utility transformer, ground per utility company requirements and standards.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters

enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

- F. 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 below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street

- side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- F. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building area or item indicated.
1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches from building's foundation.
- G. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- 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.
- 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- 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. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 - 3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 - 4. Substations and Pad-Mounted Equipment: 5 ohms.
 - 5. Manhole Grounds: 10 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Hangers.
 - b. Steel slotted support systems.
 - c. Nonmetallic support systems.
 - d. Trapeze hangers.
 - e. Clamps.
 - f. Turnbuckles.
 - g. Sockets.
 - h. Eye nuts.
 - i. Saddles.
 - j. Brackets.
2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Nonmetallic slotted-channel systems.
4. Equipment supports.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

- 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, using input from installers of the items involved:
1. Suspended ceiling components.
 2. Structural members to which hangers and supports will be attached.
 3. Size and location of initial access modules for acoustical tile.
 4. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.

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. Channel Width: 1-5/8 inches.
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 6. Channel Dimensions: Selected for applicable load criteria.
- B. Aluminum Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
1. Channel Width: 1-5/8 inches.
 2. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

4. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 5. Channel Dimensions: Selected for applicable load criteria.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
1. Channel Width: 1-5/8 inches.
 2. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
 4. Rated Strength: Selected to suit applicable load criteria.
 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Conduit and Cable Support Devices: Steel, Stainless-steel or Glass-fiber-resin hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. 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 made of malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: Stainless-steel springhead type.
7. 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 unless requirements in this Section are stricter.
- B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

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: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 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 the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

END OF SECTION 260529

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SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing
- B. FMC: Flexible metal conduit
- C. GRC: Galvanized rigid steel conduit.
- D. MC: Metal Clad Cable
- E. LFMC: Liquid-tight flexible metal conduit
- F. RNC: Rigid nonmetallic conduit

1.3 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. MC: Comply with UL 1569 and NEC article 330.
- D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1,
 - 2. External PVC Coating Thickness: 0.040 inch, minimum.
 - 3. Internal urethane coating Thickness: 0.002 inch, minimum.
 - 4. Hot dipped galvanized threads
 - 5. PVC Coating shall be of the same manufacturer of the conduit.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. FMC: Comply with UL 1; single strip, continuous, flexible interlocked double-wrapped steel, galvanized inside and outside forming smooth internal wiring channel.
- G. LFMC: Flexible steel conduit with PVC jacket, UV stable, machine tool gray in color, lightweight aluminum core internal construction and complying with UL 360.
- H. Fittings for Metal Conduit Comply with NEMA FB 1 and UL 514:
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Set screw.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Fittings for PVC-coated Rigid Steel Conduits: Minimum PVC thickness of 0.040 inch, 0.002 inch thickness of internal urethane, overlapping sleeves protecting threaded joints. All conduit bodies shall be NEMA 4x Rated with encapsulated stainless steel screws.

5. Fittings for LFMC: Body, gland and lock nut shall be steel of malleable iron. Ground cone shall be steel, sealing ring and insulator shall be blue molded thermoplastic at 150°C (221°F) maximum.
6. Fittings for GRC: Threaded rigid steel conduit fittings. Comply with NEMA FB 2.10.
- I. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. RNC: Type EPC-40-PVC for 90°C, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Materials must have tensile strength of 7,000-7,200 psi at 73.4°F, flexural strength of 12,000 psi and compressive strength of 9,000 psi.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- E. Raceway, fittings, and cement must be produced by the same manufacturer who must have had a minimum of ten (10) years' experience in manufacturing of these products.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Wireway Covers: Hinged cover secured with captive screws unless otherwise indicated.
- D. Finish: Manufacturer's standard enamel finish NEMA 250 rated.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways:
 - 1. Refer to drawings for location(s), type(s), and quantity(s) of surface metal raceway.
 - a. Surface finish: be satin, anodized #204 type clear, Class R1 mil-Spec with minimum anodized finish of .004" unless otherwise noted.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1.

- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- J. Gangable boxes are allowed.
- K. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

2.8 MANUFACTURERS

- A. Raceway and Fitting Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):

1. Wheatland Tube
2. Allied Tube & Conduit
3. Thomas & Betts
4. Hubble
5. Legrand
6. Calbond
7. Western Tube and Conduit
8. Republic Conduit

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. The following application must be adhered to. Raceways installed that are not conforming to this listing must be removed and replace with specified material at no additional expense.

Raceway Types	Applications
Galvanized Rigid Steel Conduit (GRC)	Where exposed to mechanical injury, where specifically required; indoors where exposed to moisture; where required by codes and for all circuits in excess of 600 volts. Outdoor locations, sump and ejector pits, elevator pits, loading docks, garage, rooftops and gymnasium.
PVC Coated Galvanized Rigid Steel Conduit (GRC)	Where exposed to extreme outdoor and indoor corrosion and or weather conditions: Stub out of Concrete applications. In applications where two (2) UL Listed Layers of Corrosion protection is required and Hot Dipped Galvanized Conduit as Primary Protection is listed PVC Coating is listed as Primary Corrosion is also UL Listed.
Electrical Metallic tubing	Use in every instance except where another

Raceway Types	Applications
(EMT)	material is not specified.
Metal Clad Cable (MC)	Lighting and receptacle branch circuits concealed in dry hollow spaces of a building. May not be used in areas where it would be subjected to physical damage, or where prohibited by Code.
Flexible Metal Conduit	Use in dry areas for connections to lighting fixtures in hung ceilings, connections to equipment installed in removable panels of hung ceilings; at all transformer or equipment raceway connections where sound and vibration isolation is required.
Liquid-Tight Flexible Metal Conduit	Use in areas subject to moisture where flexible metal conduit is unacceptable, at connections to all motors, and all raised floor areas.
Rigid Non-Metallic Conduit	Schedule 40 - Where raceways are in a slab below grade levels; for raceway duct banks. Schedule 80 - For underground raceways outside of the building which are not encased in concrete.
Wireways and Auxiliary Gutters	Where indicated on the Contract Documents and as otherwise specifically required.
Boxes and Enclosures	NEMA 250, Type 1, except use NEMA 250, Type 4 in kitchens and damp/or wet locations. Outdoors use NEMA 250, Type 3R.

- B. Provide separate raceways for all wiring systems, including security, data, paging, low voltage et al. All 480Y/277-volt wiring must be kept independent of 208Y/120 volt wiring. Emergency system wiring must be kept independent of the normal system wiring. Provide grounding conductor within all circuits. Minimum size 3/4-inch for home runs and 1-inch minimum for power distribution. Wiring of each type and system must be installed in separate raceways.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Galvanized Steel Conduit (GRC): Use threaded rigid steel conduit fittings. Comply with NEMA FB 2.10.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use setscrew steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Install surface raceways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Provide one (1) empty 3/4 inch raceway for each three (3) spare unused poles or spaces of each flush-mounted panelboard. Terminate empty 3/4 inch conduits in a junction

box, which after completion is accessible to facilitate future branch circuit extension. Provide pull lines in each raceway.

- J. Raceways in hung ceilings shall be installed on and secured to the slab or primary structural members of the ceiling, not to lathing channels or T-bars, Z-bars or other elements which are direct supports of the ceiling panels. Secure conduit firmly to the steel with clips and fittings designed for that purpose. Install as high as possible but not less than 1'-0" above the hung ceilings.
- K. Raceways Embedded in Slabs:
 - 1. Install no raceway in the concrete slab except with the permission of the Structural Engineer and written consent of the Owner.
 - 2. Do not install raceways larger than 1-1/4 inch size in structural concrete slabs.
 - 3. In no case will the installation of raceways be permitted to interfere with proper placement of principal reinforcement.
 - 4. Place raceways in the structural slabs between the upper and lower layers of reinforcing steel. Careful bending of the conduits is required.
 - 5. Space the raceways embedded in concrete slabs not less than eight (8) inches on centers and as widely spaced as possible where they converge at panels or junction boxes.
 - 6. Install raceways running parallel to slabs supports, such as beams, columns and structural walls, not less than 12 inches from such supporting elements.
 - 7. Secure saddle supports for conduit, outlet boxes, junction boxes, inserts, etc. with suitable adhesives during concrete pour of the slab to prevent displacement.
 - 8. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- L. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- M. 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.
- N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

- P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- U. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- V. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- X. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Y. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Z. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

AA. OUTLET, JUNCTION, AND PULL BOXES

1. Provide outlet, junction, and pull boxes as indicated on the Contract Documents and as required for the complete installation of the various electrical systems, and to facilitate proper pulling of the cables. Size the junction boxes and pull boxes per the NEC. Size the boxes on any empty conduit systems as if containing conductors of No.4 AWG.

2. The exact location of outlets and equipment is governed by the structural conditions and obstructions, or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to the room layout and will not interfere with other work or equipment. Verify final location of outlets, panels equipment, etc., with the Architect prior to installation.
3. Back-to-back outlets in the same wall, or "thru-wall" type boxes are not permitted. Provide 12-inch minimum spacing for outlets shown on opposite sides of a common wall to minimize sound transmission.
4. Fit outlet boxes in finished ceilings or walls with appropriate covers, set flush with the finished surface. Where more than one (1) switch or device is located at one (1) point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes are not permitted. Provide tile box or 4 inch square box with tile ring in masonry walls not plastered or furred. Where drywall material is utilized, provide plaster ring. Provide outlet boxes of type and size suitable for the specific application. Where outlet boxes contain two (2) or more 277 volt devices, or where devices occur of different applied voltages, or where normal and emergency devices occur in the same box, provide suitable barrier(s).
5. All outlet and device box depths shall have sufficient depth to prevent damage to the conductors when devices or utilization equipment are installed as intended in the box.
6. Types of Boxes and Fittings for Various Locations:

Location	Type
Outlet	Galvanized pressed steel
Outlet exposed to moisture or outdoors	Cast type conduit fitting
Splice	Galvanized pressed steel
Splice exposed to moisture or outdoors	Cast type conduit fitting or sheet metal (4½" x 5" x 3" minimum)
Pull or Junction	Cast type conduit fitting or sheet metal (4½" x 5" x 3" minimum)
Pull or Junction - Outdoors	Aluminum (4½" x 5" x 3" minimum)
Terminal	Sheet steel (6" x 6" x 3" minimum)
Terminal - Outdoors	Aluminum (6" x 6" x 3" minimum)

BB. PULL BOX SPACING

1. Provide pull boxes so no individual conduit run contains more than the equivalent of four (4) quarter bends (360° total).
2. Conduit Sizes 1¼" and Larger:
 - a. Provide boxes to prevent cable from being excessively twisted, stretched or flexed during installation.
 - b. Provide boxes so that maximum pulling tensions do not exceed the cable manufacturer's recommendations.
 - c. Provide support racks for boxes with multiple sets of conductors so that the conductors do not rest on any metal work inside the box.
3. Conduit Sizes 1 inch and Smaller, provide boxes at every (Maximum Distances):

Distance	Run Type
150 feet	straight runs
100 feet	runs with one (1) 90° bend or equivalent
75 feet	runs with two (2) 90° bends or equivalent
50 feet	runs with three (3) or (4) four 90° bends or equivalent.

- CC. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- DD. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- EE. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- FF. Locate boxes so that cover or plate will not span different building finishes.
- GG. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- HH. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- II. Set metal floor boxes level and flush with finished floor surface.

- JJ. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified elsewhere in the project specifications for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified elsewhere in the project specifications.
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 elsewhere in the project specifications.
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of all fire-rated floor and wall assemblies, per the project specifications.

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

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SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

1.2 SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.3 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. 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.

- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

1.2 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.

- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - 1. Color shall be factory applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 240-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - 4. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 5. Color for Neutral: White.
 - 6. Color for Equipment Grounds: Green.
 - 7. Colors for Isolated Grounds: Green with white stripe.
- C. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.

- D. Warning labels and signs 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."

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
- C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and is 12 inches wide. Stop stripes at legends.
- D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.
- E. Underground-Line Warning Tape:
 - 1. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 2. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015-inch-thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

C. Write-on Tags:

1. Polyester Tags: 0.010-inch-thick, with corrosion-resistant grommet and cable tie for attachment.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel 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.

B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and 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.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and 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.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F.
 5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain 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 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- I. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- K. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- L. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- M. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

- N. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. 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.
- P. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- Q. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- R. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- S. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- T. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- U. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- V. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
 - 2. Limit use of underground-line warning tape to direct-buried cables.
- W. Metal Tags:
 - 1. Place in a location with high visibility and accessibility.
- X. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.

Y. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

Z. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

AA. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

BB. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

END OF SECTION 260553

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SECTION 260921 - LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. General: Provide lighting control equipment, devices and wiring as indicated.

1.2 SUBMITTALS

- A. Product Data: Manufacturer's cut sheets and descriptive literature for equipment and devices to be used on the Project, indicating compliance with the specifications. Include typical wiring diagrams.

PART 2 - PRODUCTS

2.1 LIGHTING CONTROLS- GENERAL

- A. General: System providing distributed occupancy sensor on-off control, manual dimming and/or on-off control via lighting power packs and associated devices, for interior lighting fixtures as indicated.
- B. Type of Controls: All low-voltage-controlled circuits to include the indicated automatic and/or manual controls. Provide lighting power packs, remote switches/dimmers, occupancy sensors, control modules, etc. as indicated.
- C. Dimming: All dimming controls to be 0-10VDC. For each circuit with dimming control, provide definite contact-break on-off control as well, via lighting power pack.
- D. Network: All lighting power packs and control devices to be connected via separate dedicated Cat-5 Ethernet cabling system.
- E. Complete: Provide all necessary components and wiring as required for the specified and indicated control and control sequences.

2.2 ACCEPTABLE MANUFACTURERS

- A. Acuity Controls "nLight".

2.3 LIGHTING CONTROLS

- A. Device Colors: Match Project general wiring device color (generally Black). Confirm with Architect.
- B. Device Legends: Custom engraved identification for each button for each station as assigned/directed by Engineer.
- C. On-Off Switches: Acuity Controls #nPODMA-color.
- D. Double On-Off Switches: Acuity Controls #nPODMA-2P-color.
- E. Quad On-Off Switches: Acuity Controls #nPODMA-4P-color. With custom engraved switch legends as indicated or directed.
- F. On-Off Plus 0-10V Dimmer Switches: Acuity Controls #nPODMA-DX-color.
- G. Double On-Off Plus 0-10V Dimmer Switches: Acuity Controls #nPODMA-2P-DX-color.
- H. Quad On-Off Plus 0-10V Dimmer Switches: Acuity Controls #nPODMA-4P-DX-color. With custom engraved switch legends as indicated or directed.
- I. Four-Scene Preset Stations with On-Off and Raise-Lower: Acuity Controls #nPODMA-4SB-DX-color.
- J. Digital Dimming Touch Screen Time Clocks: Acuity Controls #nDTC series.
- K. Occupancy Sensor Wall Switches with 0-10V Dimmer: Acuity Controls #WSXA-PDT-color.
- L. Occupancy Sensor Wall Switches: Acuity Controls #WSXA-PDT-color.
- M. Ceiling Mounted Occupancy Sensors: Acuity Controls #nCM-PDT-9-RJB (small motion); nCM-PDT-10-RJB (large motion).
- N. Corner Mounted Occupancy Sensors: Acuity Controls #nWV-16-KIT.
- O. Lighting Power Packs: Acuity Controls #nPP16-EFP.
- P. Lighting Power Packs for 0-10V Dimming: Acuity Controls #nPP16-D-EFP.
- Q. Control Cables Between nLight Devices: Cat-5E, pre-terminated with non-booted connectors, plenum-rated. Acuity Controls #CAT5 series.
- R. Control Cables for 0-10V Diming Circuits to Lighting Fixtures: Class II, size as required, plenum-rated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install all equipment as recommended by the equipment manufacturer. Use only one manufacturer for all devices and equipment described in this Section.
- B. Connections: Install and connect all devices to each other and to all respective controlled lighting fixtures per the manufacturer's written instructions and for the indicated operation and control. Extend 0-10VDC dimming control wiring from each lighting dimming power pack to all its respective dimmed lighting fixtures.
- C. Programming and Setting Adjustments: Program each device/equipment requiring same. Adjust field of views, sensitivities and time delays as required for optimum control.
- D. Control Wiring: Provide all necessary control wiring for total and satisfactory system operation. Low voltage control wiring may be run without conduit above suspended ceilings. Neatly support and secure cables to building structure above ceiling. Provide conduit protection wherever cables penetrate fire barriers, are exposed or susceptible to damage.

3.2 OCCUPANCY SENSOR WALL SWITCHES AND OCCUPANCY SENSORS

- A. Locations: Install sensors in the general locations indicated. Adjust exact locations if required to comply with manufacturer's recommendations for optimum placement and control.
- B. Operation: In general, all general illumination lighting fixtures in a room (or area) are to be controlled by the sensor(s) in the same room (area). Lights shall remain on as long as at least one sensor in room detects occupancy. When occupancy is no longer detected, lights to turn off after set time delay

3.3 LOW VOLTAGE MANUAL CONTROLS

- A. Low Voltage Switches and Dimming Control Switches: Install where indicated, and connect and program for the indicated control.

3.4 TESTS

- A. General: Test all equipment and devices for proper operation. Correct/adjust as required.

3.5 OWNER INSTRUCTION

- A. General: Instruct the owner's representative(s) (minimum one one-hour session) in the operation and maintenance of each type of equipment and device, to the Owner's satisfaction.

END OF SECTION 260921

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Photoelectric switches.
2. Standalone daylight-harvesting dimming controls.
3. Indoor occupancy and vacancy sensors.
4. Switchbox-mounted occupancy sensors.
5. Digital timer light switches.
6. Emergency shunt relays.

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:
 - a. Daylight-harvesting dimming controls.
 - b. Occupancy sensors.
 - c. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or on manufacturer's website. Provide names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.

1.4 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices.
 2. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Description: Solid state, with dry contacts, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 3. Time Delay: Fifteen-second minimum, to prevent false operation.
 4. Surge Protection: Metal-oxide varistor.
 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
 6. Failure Mode: Luminaire stays ON.

2.2 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

- B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated or separate power pack mounted on luminaire, to detect changes in indoor lighting levels that are perceived by the eye.
- C. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
 - 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.
- D. Power Pack: Dry contacts rated for 20A ballast or LED load at 120V and 277V AC, for 13A tungsten at 120V AC, and for 1 HP at 120V AC. Sensor has 24V DC, 150mA, Class 2 power source, as defined by NFPA 70.
 - 1. LED status lights to indicate load status.
 - 2. Plenum rated.
- E. Power Pack: Digital controller capable of accepting 3 RJ45 inputs with two outputs rated for 20A incandescent or LED load at 120V and 277V AC, for 16A ballast load or LED at 120V and 277V AC, and for 1 HP at 120V AC. Sensor has 24V DC Class 2 power source, as defined by NFPA 70.
 - 1. With integral current monitoring
 - 2. Compatible with digital addressable lighting interface.
 - 3. Plenum rated.

2.3 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. General Requirements for Sensors:
 - 1. Wall and Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 - 2. Dual technology.
 - 3. Integrated or Separate power pack.
 - 4. Hardwired or Wireless connection to switch and BAS; and BAS and lighting control system.
 - 5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.

- b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 - c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 - 7. Power: Low voltage or Line voltage.
 - 8. 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.
 - 9. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 10. Bypass Switch: Override the "on" function in case of sensor failure.
 - 11. Automatic Light-Level Sensor: Adjustable from 2 to 100 fc; turn lights off when selected lighting level is present.
 - B. Dual-Technology Type: Wall or Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 3. Detection Coverage: Select sensor(s) to provide full coverage of room and detect occupancy anywhere within the room where installed.
- 2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS
- A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Sensing Technology – Dual Technology.

2.5 DIGITAL TIMER LIGHT SWITCH

- A. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval.

1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
2. The digital time switch shall be programmable to turn lights off after a preset time.
3. Time switch shall be a completely self-contained control system that replaces the standard toggle switch. It shall have a ground wire and ground strap for safety. Switching mechanism shall be a latching air gap relay.
4. Zero Crossing Circuitry shall be used to increase the relay life, protect from the effects of inrush current, and increase the switch's longevity.
5. Time switch shall be compatible with all electronic ballasts, motor loads, compact fluorescent and inductive loads. Triac and other harmonic generating devices shall not be allowed.
6. Time switch shall have no minimum load requirement and shall be capable of controlling all types of light sources.
7. Time scroll feature shall allow manual overriding of the preset time-out period.
8. Time switch shall have the option for a one second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).
9. Time switch shall have the option for a beep warning that shall sound every five seconds once the time switch countdown reaches one minute.
10. Time switch shall have manual feature for timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.
11. Time switch shall have an electroluminescent backlit Liquid Crystal Display that shows the timer's countdown.
12. Time switch shall fit behind a decorator style faceplate. The calibration switch for setting time-out, time scroll, one second light flash, and beep warning shall be concealed to prevent tampering of adjustments and hardware.
13. Time-out period shall be adjustable in increments of 5 minutes from 5 minutes to 1 hour, and in increments of 15 minutes from 1 hour to 12 hours.
14. Time switch shall be capable of operating as an ON/OFF switch.

15. For safety, the time switch shall have a 100% OFF override switch with no leakage current to the load.
16. For safety, in the event there is an open circuit in the AC line such as a ballast or lamp failure, the time switch shall automatically switch to OFF mode

2.6 EMERGENCY SHUNT RELAY

- A. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
 1. Coil Rating: 120 and 277 V.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.

- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 LIGHTING SYSTEM FUNCTIONAL TESTING

- A. The lighting control system manufacturer, manufacturer's authorized representative, or a qualified testing agency shall perform all functional testing required by the 2015 International Energy Conservation Code, Section C408.
- B. Functional Testing:
 - 1. Prior to passing final inspection, the manufacturer's authorized representative shall provide evidence that the lighting control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's instructions.
- C. Occupancy Sensor Controls:
 - 1. Certify that the occupancy sensors have been located and aimed in accordance with manufacturer recommendations.
 - a. For projects with seven or fewer sensors, each sensor shall be tested.
 - b. For projects with more than seven sensors, testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each unique combination of sensor type and space geometry are provided, not less than 10 percent, but in no case less than one, of each

combination shall be tested. Where 30 percent or more of the tested controls fail, all remaining identical combinations shall be tested.

2. For occupancy sensor controls to be tested, verify the following:
 - a. Where occupancy sensor controls include status indicators, verify correct operation.
 - b. The controlled lights turn off or down to the permitted level within the required time.
 - c. For auto-on sensors, the lights turn on to the permitted level when an occupant enters the space.
 - d. For manual-on sensors, the lights turn on only when manually activated.
 - e. The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

D. Time Switch Controls:

1. Where time switch controls are provided, the following procedures shall be performed:
 - a. Confirm that the time-switch control is programmed with accurate weekday, weekend and holiday schedules.
 - b. Provide documentation to the owner of time switch controls programming including weekday, weekend, holiday schedules, and set-up and preference program settings.
 - c. Verify the correct time and date in the time switch.
 - d. Verify that any battery backup is installed and energized.
 - e. Verify that the override time limit is set to not more than 2 hours.
2. Simulate occupied condition. Verify and document the following:
 - a. All lights can be turned on and off by their respective area control switch.
 - b. The switch only operates lighting in the enclosed space in which the switch is located.
3. Simulate unoccupied condition. Verify and document the following:
 - a. Nonexempt lighting turns off.
 - b. Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.

E. Daylight Responsive Controls:

1. Where daylight responsive controls are provided, the following shall be verified:
 - a. Control devices have been properly located, field calibrated and set for accurate set points and threshold light levels.
 - b. Daylight controlled lighting loads adjust to light level set points in response to available daylight.
 - c. The locations of calibration adjustment equipment are readily accessible only to authorized personnel.

F. Documentation Requirements:

1. Documents certifying that the lighting controls meet documented performance criteria of the IECC are to be provided to the building owner within 90 days from the date of receipt of the certificate of occupancy.

3.6 TRAINING

- A. The lighting control system manufacturer or the manufacturer's authorized representative shall conduct formal training for all users of the automatic lighting control systems.

END OF SECTION 260923

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.

5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.
10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

C. Qualification Data: For testing agency.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in other sections, include the following:
 - a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - b. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.8 FIELD CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than five business days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's written permission.
 - 3. Comply with NFPA 70E.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. 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.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3.
 - c. Kitchen and Wash-Down 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 12.
 - 2. Height: 84 inches maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 - 4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 5. Finishes:
 - a. Panels and Trim: 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: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- F. Incoming Mains:
 - 1. Location: Convertible between top and bottom.
 - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- G. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity, depending on rating of panelboard.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
 5. Split Bus: Vertical buses divided into individual vertical sections.
- H. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate on load side of main device unless otherwise noted on plans.
 8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
- I. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: See drawings.
- K. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

- A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1 or Type 2.

2.3 DISTRIBUTION PANELBOARDS

- A. Approved manufactures:
 1. Square D: I-Line
 2. Eaton: Pow-R-Line 4,
 3. Siemens: Type P4/P5
 4. General Electric: Spectra Series
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Approved manufacturers:
 1. Eaton
 2. Square D
 3. Siemens
 4. General Electric
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Electronic Trip Circuit Breakers:
 - a. 100 percent rated
 - b. RMS sensing.
 - c. Field-replaceable rating plug or electronic trip.
 - d. Digital display of settings, trip targets, and indicated metering displays.
 - e. Multi-button keypad to access programmable functions and monitored data.
 - f. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - g. Integral test jack for connection to portable test set or laptop computer.
 - h. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
 - 2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 - 3. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 4. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 - 5. Subfeed Circuit Breakers: Vertically mounted.
 - 6. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.

- f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- g. Communication Capability: Circuit-breaker-mounted or integral communication module with functions and features compatible with power monitoring and control system.
- h. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
- i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
- j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
- k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- l. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- m. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
- n. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
- o. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

2.6 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NEMA PB 1.1.
- D. Equipment Mounting:
 - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount top of trim at a height so that the operating handle of the top-most switch or circuit breaker, in ON position, is not higher than 79 inches (2000 mm) above finished floor or grade, unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

- I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- J. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- L. Install filler plates in unused spaces.
- M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- N. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with the project specification requirements for identification.
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with the project specifications.
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with the project specifications.
- E. Install warning signs complying with requirements of the project specifications.

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:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. 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. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. 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 the Electrical Power System Study, required per specification section 260573 and furnished by the Electrical Contractor.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Engineer of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Owner.

3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.
5. Update panelboard directories accordingly, and provide updated directories to Owner within five business days of load balancing.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Straight-blade convenience, isolated-ground, and tamper-resistant receptacles.
2. GFCI receptacles.
3. Toggle switches.
4. Wall-box dimmers.
5. Wall plates.

1.2 SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: One for each type of device and wall plate specified, in each color specified.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices for Owner-Furnished Equipment:
1. Receptacles: Match plug configurations.
 2. Cord and Plug Sets: Match equipment requirements.
- D. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

- A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

- B. Isolated-Ground, Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

- 1. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

- C. Tamper-Resistant Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.3 GFCI RECEPTACLES

- A. General Description:

- 1. 125 V, 20 A, straight blade, feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

2.4 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

- B. Switches, 120/277 V, 20 A:

- C. Pilot-Light Switches: 120/277 V, 20 A.

- 1. Description: Single pole, with LED-lighted handle, illuminated when switch is off.

- D. Key-Operated Switches: 120/277 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: 120/277 V, 20 A; for use with mechanically held lighting contactors.

- F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

2.5 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider or toggle switch; with single-pole or three-way switching. Comply with UL 1472.
- C. 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 20 percent of full brightness.
- D. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.6 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: As selected by the Architect.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.7 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. SPD Devices: Blue.
 - 4. Isolated-Ground Receptacles: Orange.
- B. Wall Plate Color: As selected by the Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

TYPICAL MOUNTING HEIGHTS	
DEVICE	MOUNTING HEIGHT
Wall switches, card readers	48 inches above finished floor to center
Receptacle outlets, data outlets, CATV outlets	18 inches above finished floor to center
Receptacle outlets – above counter	42 inches above finished floor to center, or 8 inches to center above countertops
Wall telephone outlets	48 inches above finished floor to center
Clock outlets	96 inches above finished floor to center, or 6 inches below ceiling. Above doors, centered between door trim and ceiling

- B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

- C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail or replace all damaged conductors.

- b. Straighten conductors that remain and remove corrosion and foreign matter.
- c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

- 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
- 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
- 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
- 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
- 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
- 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
- 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
- 8. Tighten unused terminal screws on the device.
- 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

- 1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. 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.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. 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 unacceptable.
 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. 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.
- D. Wiring device will be considered defective if it does not pass tests and inspections.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.2 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.3 MAINTENANCE MATERIAL SUBMITTALS

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

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturer shall be the same as the switchboards and panelboards.
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 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, 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. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 5. Service-Rated Switches: Labeled for use as service equipment.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturer shall be the same as the switchboards and panelboards.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.
- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F (75 deg C) temperature rating in NFPA 70.
- G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.

- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal 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.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- M. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- N. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- O. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system.
 - 6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Alarm Switch: One NO/NC contact that operates only when circuit breaker has tripped.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Provide remote control for on, off, and reset operations.

2.4 MOLDED-CASE SWITCHES

- A. Manufacturer shall be the same as the switchboards and panelboards.
- B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 1. Standard frame sizes and number of poles.
 2. Lugs:
 - a. Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 - b. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.
 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 6. Alarm Switch: One NO/NC contact that operates only when switch has tripped.
 7. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
 8. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
 9. Electrical Operator: Provide remote control for on, off, and reset operations.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) gray baked enamel paint, or electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- E. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than five business days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3.
 - 3. Kitchen and Wash-Down 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.

3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain code required workspace clearances and required clearances for equipment access doors and panels, regardless of location indicated on the drawings.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

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 the Electrical Power System Study, required per specification section 260573 and furnished by the Electrical Contractor.

END OF SECTION 262816

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SECTION 265001 - LIGHTING FIXTURE SCHEDULE

* MANUFACTURERS AND MODELS/NUMBERS LISTED ARE TO ESTABLISH TYPE, QUALITY AND PERFORMANCE.

COMPETING MANUFACTURERS/MODELS/NUMBERS WILL BE ACCEPTED IF OF EQUAL OR COMPARABLE TYPE, CONSTRUCTION, QUALITY, PERFORMANCE AND DETAIL.

ALL MOUNTING OPTIONS AND FINISH COLORS TO BE CONFIRMED WITH ARCHITECT.

TYPE	DESCRIPTION	MOUNTING	LAMPING	BALLAST(S)/ DRIVER(S)	VOLTS	MANUFACTURER SERIES & NO. *	NOTES
D2 D2E	LED ROUND DOWNLIGHT: 6" DIAMETER X 4.75" HIGH, 16-GAUGE STEEL AND LEXAN CONSTRUCTION, SHATTERPROOF ACRYLIC 1.1" REGRESSED BEZEL WITH 40-DEGREE DIFFUSED LENS, WHITE BEZEL AND TRIM, UL DAMP LABEL *D1E: ADD 90-MINUTE EMERGENCY BATTERY BACK-UP	RECESSED CEILING	LED'S 3000K, 90 CRI 1,402 LUMENS 70 LUMENS/WATT L70 @ 66,000 HOURS	INTEGRAL DRIVER 0-10V, 1% DIMMING 17W	120-277V	ALPHABET "NU6" #NU6-RD-SW-20LM-35K-90-HE40- WH-WH-RET-UNV-DIM10- *EM12	AUDITORIUM ENTRIES
D3	LED ROUND DOWNLIGHT: 4" DIAMETER X 4.5" HIGH, 16-GAUGE COLD-ROLLED STEEL AND LEXAN CONSTRUCTION, SHATTERPROOF ACRYLIC 3/4" REGRESSED BEZEL WITH HIGH EFFICIENCY TEXTURED LENS, 35-DEGREE BEAM OPTICS, BRONZE BEZEL AND WHITE TRIM, UL DAMP LABEL, UGR < 19	RECESSED CEILING	LED'S 3000K, 90 CRI 1,260 LUMENS 105 LUMENS/WATT L70 @ 66,000 HOURS	INTEGRAL 0-10V, 1% DIMMING 12W	120-277V	ALPHABET "NU4" #NU4-RD-SW-15LM-30K-90-35D- HET-WH-BZ-RET-UNV-DIM10	CONTROL BOOTH STAIR ENTRY
D4 D4E	LED ROUND DOWNLIGHT: 6" DIAMETER X 4.75" HIGH, 16-GAUGE STEEL AND LEXAN CONSTRUCTION, SHATTERPROOF ACRYLIC 1.1" REGRESSED BEZEL WITH 40-DEGREE DIFFUSED LENS, WHITE BEZEL AND TRIM, UL DAMP LABEL *D4E: ADD 90-MINUTE EMERGENCY BATTERY BACK-UP	RECESSED CEILING	LED'S 3000K, 90 CRI 1,402 LUMENS 70 LUMENS/WATT L70 @ 66,000 HOURS	INTEGRAL DRIVER 0-10V, 1% DIMMING 17W	120-277V	ALPHABET "NU6" #NU6-RD-SW-20LM-30K-90-HE40- WH-BZ-RET-UNV-DIM10- *EM12	CONTROL BOOTH STAIRS
D5	LED ROUND DOWNLIGHT: 6" DIAMETER X 4.75" HIGH, 16-GAUGE STEEL AND LEXAN CONSTRUCTION, SHATTERPROOF ACRYLIC 1.1" REGRESSED BEZEL WITH 40-DEGREE DIFFUSED LENS, BLACK BEZEL AND TRIM, UL DAMP LABEL	RECESSED CEILING	LED'S 3000K, 90 CRI 1,690 LUMENS 85 LUMENS/WATT L70 @ 66,000 HOURS	INTEGRAL DRIVER 0-10V, 1% DIMMING 20W	120-277V	ALPHABET "NU6" #NU6-RD-SW-25LM-30K-90-HE40- BK-BK-RET-120-DIM10	CONTROL BOOTH

TYPE	DESCRIPTION	MOUNTING	LAMPING	BALLAST(S)/ DRIVER(S)	VOLTS	MANUFACTURER SERIES & NO. *	NOTES
E1	<u>LED RECESSED CEILING EMERGENCY LIGHTING UNIT</u> : 10" X 6" RECTANGULAR TRIM, HIGH IMPACT UV-STABLE THERMOPLASTIC HOUSING, FOUR INTEGRATED ADJUSTABLE LED HEADS, 4.8V 90-MINUTE NICKEL METAL HYDRIDE BATTERY, SELF-DIAGNOSTICS, TEXTURED WHITE FINISH	RECESSED CEILING	4- 1W LED LAMP HEADS	INTEGRAL DRIVER(S) 4W	120/277V	ISOLITE "ELF" #ELF-4W-WH-MRC-SD-RECT	GENERAL USE
E2	<u>LED RECESSED CEILING EMERGENCY LIGHTING UNIT</u> : 10" X 6" RECTANGULAR TRIM, HIGH IMPACT UV-STABLE THERMOPLASTIC HOUSING, FOUR INTEGRATED ADJUSTABLE LED HEADS, 4.8V 90-MINUTE NICKEL METAL HYDRIDE BATTERY, SELF-DIAGNOSTICS, TEXTURED BLACK FINISH	RECESSED CEILING	4- 1W LED LAMP HEADS	INTEGRAL DRIVER(S) 4W	120/277V	ISOLITE "ELF" #ELF-4W-BK-MRC-SD-RECT	CONTROL BOOTH
E3	<u>LED EMERGENCY LIGHT</u> : BLACK UV-STABILIZED INJECTION MOLDED ABS HOUSING, TWIN ADJUSTABLE LAMP HEADS, EXTRUDED ALUMINUM HEAT SINKS, 90-MINUTE MAINTENANCE-FREE NI-CAD BATTERY BACK-UP, SELF-DIAGNOSTICS, UL DAMP LABEL	SURFACE WALL	(2) 6V, 6W LED'S 650 LUMENS/HEAD	INTEGRAL DRIVER	120-277V	ISOLITE "BUG" #BUG-6W-BK-MB-SD	WHITNEY AUDITORIUM STAGE
E4	<u>LED EMERGENCY LIGHT</u> : 20-GAUGE BLACK STEEL HOUSING, TWIN ADJUSTABLE LAMP HEADS, 90-MINUTE MAINTENANCE-FREE NI-CAD BATTERY BACK-UP, WIRE GUARD	SURFACE WALL	(2) 12V, 7W LED'S 950 LUMENS/HEAD	INTEGRAL DRIVER	120-277V	ISOLITE "ELH" #ELH-NC-12V2—W-BK-MB-2-XRH- L127-WG-20.0LX19.0WX9.0D	WHITNEY AUDITORIUM STAGE

TYPE	DESCRIPTION	MOUNTING	LAMPING	BALLAST(S)/ DRIVER(S)	VOLTS	MANUFACTURER SERIES & NO. *	NOTES
H1	<p><u>LED ROUND DOWNLIGHT</u>: 4" DIAMETER X 4.5" HIGH, 16-GAUGE COLD-ROLLED STEEL AND LEXAN CONSTRUCTION, SHATTERPROOF ACRYLIC 3/4" REGRESSED BEZEL WITH HIGH EFFICIENCY TEXTURED LENS, 35-DEGREE BEAM OPTICS, BRONZE BEZEL AND WHITE TRIM, UL DAMP LABEL, UGR < 19</p> <p>*PROVIDE REMOTE 0-10V DRIVER CABINETS AS SCHEDULED ON DWG. E104.</p>	RECESSED CEILING (FLAT)	LED'S 3000K, 90 CRI 1,780 LUMENS 105 LUMENS/WATT L70 @ 66,000 HOURS	REMOTE DRIVER 0-10V, 1% DIMMING 17W	120-277V	<p>ALPHABET "NU4" #NU4-RD-SW-20LM-30K-90-35D- HET-WH-BZ-NC-UNV-DIM10</p> <p>ALPHABET "MEDIUM DRIVER PANEL"</p>	WHITNEY AUDITORIUM HOUSE LIGHTS- STAGE APRON- RIGHT & LEFT (LOW CEILING)
H2	<p><u>LED ROUND HIGH PERFORMANCE DOWNLIGHT</u>: 6" DIAMETER X 6" HIGH, 16-GAUGE COLD-ROLLED STEEL AND LEXAN CONSTRUCTION, SHATTERPROOF ACRYLIC 1.1" REGRESSED BEZEL WITH HIGH EFFICIENCY TEXTURED LENS, 30-DEGREE BEAM OPTICS, BRONZE BEZEL AND WHITE TRIM, UL DAMP LABEL, UGR < 16</p> <p>*PROVIDE REMOTE 0-10V DRIVER CABINETS AS SCHEDULED ON DWG. E104.</p>	RECESSED CEILING (~ 3 DEGREES SLOPED)	LED'S 3000K, 90 CRI 6,375 LUMENS 110 LUMENS/WATT L70 @ 66,000 HOURS	REMOTE DRIVER 0-10V, 1% DIMMING 58W	120-277V	<p>ALPHABET "NU6" #NU6-RDX-SW-80LM-30K-90-30D- HET-WH-BZ-NC-UNV-DIM10</p> <p>ALPHABET "MEDIUM DRIVER PANEL"</p>	WHITNEY AUDITORIUM HOUSE LIGHTS- STAGE APRON- CENTER; PIT
H3	<p><u>LED ROUND HIGH PERFORMANCE DOWNLIGHT</u>: 6" DIAMETER X 6" HIGH, 16-GAUGE COLD-ROLLED STEEL AND LEXAN CONSTRUCTION, SHATTERPROOF ACRYLIC 1.1" REGRESSED BEZEL WITH HIGH EFFICIENCY TEXTURED LENS, 40-DEGREE BEAM OPTICS, BRONZE BEZEL AND WHITE TRIM, UL DAMP LABEL, UGR < 16</p> <p>*PROVIDE REMOTE 0-10V DRIVER CABINETS AS SCHEDULED ON DWG. E104.</p>	RECESSED EXISTING PLASTER CEILING (FLAT TO ~ 3 DEGREES SLOPED)	LED'S 3000K, 90 CRI 4,470 LUMENS 106 LUMENS/ WATT L70 / 66,000 HOURS	REMOTE DRIVER 0-10V, 1% DIMMING 42W	120-277V	<p>ALPHABET "NU6" #NU6-RDX-SW-60LM-30K-90-40D- HET-WH-BZ-NC-UNV-DIM10</p> <p>ALPHABET "MEDIUM DRIVER PANEL"</p>	WHITNEY AUDITORIUM HOUSE LIGHTS- MAIN HOUSE

TYPE	DESCRIPTION	MOUNTING	LAMPING	BALLAST(S)/ DRIVER(S)	VOLTS	MANUFACTURER SERIES & NO. *	NOTES
H4	<p><u>LED ROUND HIGH PERFORMANCE DOWNLIGHT</u>: 6" DIAMETER X 6" HIGH, 16-GAUGE COLD-ROLLED STEEL AND LEXAN CONSTRUCTION, SHATTERPROOF ACRYLIC 1.1" REGRESSED BEZEL WITH HIGH EFFICIENCY TEXTURED LENS, 30-DEGREE BEAM OPTICS, BRONZE BEZEL AND WHITE TRIM, UL DAMP LABEL, UGR < 16</p> <p>*PROVIDE REMOTE 0-10V DRIVER CABINETS AS SCHEDULED ON DWG. E104.</p>	RECESSED EXISTING PLASTER CEILING (~ 3 DEGREES SLOPED)	LED'S 3000K, 90 CRI 3,436 LUMENS 101 LUMENS/ WATT L70 / 66,000 HOURS	REMOTE DRIVER 0-10V, 1% DIMMING 34W	120-277V	<p>ALPHABET "NU6" #NU6-RDX-SW-50LM-30K-90-30D- HET-WH-BZ-NC-UNV-DIM10</p> <p>ALPHABET "MEDIUM DRIVER PANEL"</p>	WHITNEY AUDITORIUM HOUSE LIGHTS- MAIN AISLES
H5	<p><u>LED ROUND HIGH PERFORMANCE DOWNLIGHT</u>: 6" DIAMETER X 6" HIGH, 16-GAUGE COLD-ROLLED STEEL AND LEXAN CONSTRUCTION, SHATTERPROOF ACRYLIC 1.1" REGRESSED BEZEL WITH HIGH EFFICIENCY TEXTURED LENS, 40-DEGREE BEAM OPTICS, BRONZE BEZEL AND WHITE TRIM, UL DAMP LABEL, UGR < 16</p> <p>*PROVIDE REMOTE 0-10V DRIVER CABINETS AS SCHEDULED ON DWG. E104.</p>	RECESSED EXISTING PLASTER CEILING (~ 3 DEGREES SLOPED)	LED'S 3000K, 90 CRI 3,436 LUMENS 101 LUMENS/ WATT L70 / 66,000 HOURS	REMOTE DRIVER 0-10V, 1% DIMMING 34W	120-277V	<p>ALPHABET "NU6" #NU6-RDX-SW-50LM-30K-90-40D- HET-WH-BZ-NC-UNV-DIM10</p> <p>ALPHABET "MEDIUM DRIVER PANEL"</p>	WHITNEY AUDITORIUM HOUSE LIGHTS- UPPER LEVEL

TYPE	DESCRIPTION	MOUNTING	LAMPING	BALLAST(S)/ DRIVER(S)	VOLTS	MANUFACTURER SERIES & NO. *	NOTES
R1	<p><u>LED STAGE RUNNING "BLUE" LIGHT:</u> TBD, FURNISHED BY DIV. 19, INSTALLED BY DIV. 26</p> <p>INCLUDES REMOTE POWER SUPPLY WITH 0-10V DIMMING DRIVER</p>	<p>SURFACE WALL USING OUTLET BOX (CONFIRM)</p>	BLUE LED	<p>REMOTE 120/24V POWER SUPPLY & 0-10V DIMMING DRIVER</p>	24V (CONFIRM)	TBD, BY DIV. 19	WHITNEY AUDITORIUM STAGE
TA1	<p><u>LED THEATRICAL AISLE STRIP LIGHT:</u> CONTINUOUS STRIP AISLE LIGHT (LENGTHS AS INDICATED), 2.4 / 3.1" WIDE BY 0.50" HIGH, LOW PROFILE, ADA COMPLIANT, FIELD CUTTABLE, DURABLE PVC TRACK AND LENS, INDIVIDUALLY REPLACEABLE SNAP-IN LED'S, 12" LED SPACING, SMOKE-COLORED LENS, AMBER COLOR LED'S</p> <p>INCLUDE ALL ACCESSORY COMPONENTS, FITTINGS, ETC. REQUIRED FOR A COMPLETE SYSTEM, INCLUDING END CAPS</p> <p>INCLUDE (4) 60W, 0-10V DIMMING POWER SUPPLIES (PLUS ONE SPARE)</p>	<p>FLOOR CARPET – TO-EDGE</p>	<p>LED'S 2700K 0.22W / LED 0.22W / FT. 100,000 HOURS</p>	<p>REMOTE 0-10V DIMMING POWER SUPPLY</p>	12V	<p>CELESTIAL LIGHTING "GEMINI 1900 PATH LIGHT" #GEM-1900-S-A-12</p> <p>CELESTIAL #DD-010-12 0-10V DIMMING POWER SUPPLY</p>	WHITNEY AUDITORIUM FRONT HOUSE AISLE LIGHTS

TYPE	DESCRIPTION	MOUNTING	LAMPING	BALLAST(S)/ DRIVER(S)	VOLTS	MANUFACTURER SERIES & NO. *	NOTES
TS1	<p><u>LED THEATRICAL WALL LIGHT:</u> (TWO RUNS, MIRROR IMAGE). FIELD CUT AND ASSEMBLED BASED ON FIELD MEASUREMENTS, LENGTHS AND CORNERS/ANGLES AS INDICATED, LOW PROFILE, ADA COMPLIANT, ALUMINUM HOUSING, LENSE-LESS DESIGN WITH NON-SCALLOPING LOUVERS/INSERTS TO SUIT EACH APPLICATION</p> <p>INCLUDE ALL ELBOWS, COUPLINGS AND ACCESSORY COMPONENTS REQUIRED FOR A COMPLETE SYSTEM, INCLUDING END CAPS</p> <p>INCLUDE (2) 60W, 0-10V DIMMING POWER SUPPLIES (PLUS ONE SPARE)</p>	SURFACE WALL	LED'S AMBER 0.3W / LED 0.3W / FT. 30,000 HOURS	REMOTE 0-10V DIMMING POWER SUPPLY	12V	<p>CELESTIAL LIGHTING "GEMINI 4000 WALL LIGHT" #GEM-4000-XXX-AAA-12-XX</p> <p>CELESTIAL #DD-010-12 0-10V DIMMING POWER SUPPLY</p>	WHITNEY AUDITORIUM UPPER HOUSE STEP LIGHTS
TS2	<p><u>LED THEATRICAL WALL LIGHT:</u> (SAME AS TYPE "TS1" ABOVE, EXCEPT DIFFERENT LENGTHS AND CONFIGURATIONS)</p> <p>INCLUDE ALL ELBOWS, COUPLINGS AND ACCESSORY COMPONENTS REQUIRED FOR A COMPLETE SYSTEM, INCLUDING END CAPS</p> <p>INCLUDE (2) 60W, 0-10V DIMMING POWER SUPPLIES (PLUS ONE SPARE)</p>		LED'S AMBER 0.3W / LED 0.3W / FT. 30,000 HOURS	REMOTE 0-10V DIMMING POWER SUPPLY	12V	<p>CELESTIAL LIGHTING "GEMINI 4000 WALL LIGHT" #GEM-4000-XXX-AAA-12-XX</p> <p>CELESTIAL #DD-010-12 0-10V DIMMING POWER SUPPLY</p>	WHITNEY AUDITORIUM UPPER HOUSE STEP LIGHTS
TS3	<p><u>LED THEATRICAL STEP LIGHT:</u> 3.5" WIDE X 2.3" HIGH X 1.1" EXT., DIECAST ALUMINUM HOUSING, ANGLED SHIELD, BLACK ANODIZED FINISH</p> <p>INCLUDE ALL ACCESSORY COMPONENTS REQUIRED FOR A COMPLETE SYSTEM</p> <p>INCLUDE (3) 60W, 0-10V DIMMING POWER SUPPLIES (PLUS ONE SPARE)</p>		LED'S AMBER-WHITE-AMBER 0.3W 50,000 HOURS	REMOTE 0-10V DIMMING POWER SUPPLY	12V	<p>CELESTIAL LIGHTING "GEMINI 6000 SEAT LIGHT" #GEM-6000-AWA-000</p> <p>CELESTIAL #DD-010-12 0-10V DIMMING POWER SUPPLY</p>	WHITNEY AUDITORIUM UPPER HOUSE STEP LIGHTS

TYPE	DESCRIPTION	MOUNTING	LAMPING	BALLAST(S)/ DRIVER(S)	VOLTS	MANUFACTURER SERIES & NO. *	NOTES
W1	<u>LED PENDANT</u> : 19" DIAMETER X 5" HIGH, TWO-PIECE DIECAST ALUMINUM HOUSING, PRECISION MOLDED MICRO PRISMATIC ACRYLIC LENSES AND BACK REFLECTORS, CONCENTRATED DISTRIBUTION, BLACK FINISH, INCLUDE PENDANT SWIVEL KIT	SHORT CONDUIT STEM (ADAPT IF REQ'D)	LED'S 3000K, 80 CRI 15,503 LUMENS 125 LUMENS/WATT L89 @ 100,000 HOURS	INTEGRAL DRIVER 0-10V, 1% DIMMING 122W	120-277V	LITHONIA "VCVL" #VCVL LED-V8-P7-30K-80CRI-T5E- MVOLT-PM-DBLXD-SLVRD	WHITNEY AUDITORIUM STAGE (ABOVE GRID IRON LEVEL)
W2	<u>LED FLOOD LIGHT</u> : 16" HIGH X 15" WIDE X 3" DEEP, DIECAST ALUMINUM HOUSING, SILICONE OPTICS, 30-DEGREE NARROW BEAM (CONFIRM), 2-3/8" KNUCKLE MOUNT, TEXTURED BLACK FINISH, HARDWARE, AND OPTIC FRAME	SURFACE WALL	LED'S 3000K, 80 CRI 11,797 LUMENS 113 LUMENS/WATT L70 @ 50,000 HOURS	INTEGRAL DRIVER 0-10V, 1% DIMMING 104W	120-277V	NLS "NV-F3" #NV-F3-55-104-30K8-UNV-KM-BLK- BH-BOF	WHITNEY AUDITORIUM STAGE WORK LIGHTS (HIGH WALL)
W3	<u>LED LINEAR STRIP LIGHT</u> : 4' LONG X 5.3" WIDE X 4.0" DEEP, STEEL CHANNEL AND COVER, INJECTION MOLDED END CAPS, WIDE DIFFUSE ACRYLIC LENS WITH 12% UPLIGHT, WIRE GUARD, MATTE BLACK FINISH	SURFACE CEILING MOUNT	LED'S 3000K, 80 CRI 3000 DELIV. LUMENS 150 LUMENS/WATT L70 @ 100,000 HOURS	INTEGRAL DRIVER 0-10V, 1% DIMMING 20W	120-277V	LITHONIA LIGHTING "CLX" #CLX-L48-SEF-WDL-WD-120- MVOLT-GZ1-30K-80CRI-BK	WHITNEY AUDITORIUM STAGE WORK LIGHTS (LOW CEILING)
W4	<u>LED INDEX RAIL LIGHT</u> : 8' LONG X 2.6"W X 13"H, EXTRUDED ALUMINUM HOUSING/WIREWAY 16-GAUGE STEEL REFLECTOR WITH WHITE FINISH, MATTE BLACK EXTERIOR FINISH, TWO SUSPENSION EYE-BOLTS, SEPARATE SWITCHING FOR EACH COLOR LAMPING PROVIDE (1) DIMMER CONTROL BOX WITH TWO 12V POWER SUPPLIES, ONE EACH FOR WHITE AND BLUE	CABLE SUSPENDED FROM LOADING BRIDGE BY DIV. 19	18 EACH WARM WHITE & BLUE LED'S PER FT	REMOTE POWER SUPPLY & DIMMER CONTROL BOX	120V TO POWER SUPPLY; 12V TO FIXTURES	SSRC "LED INDEX RAIL LIGHT" #LED-IRL-8-1B-1W #LED-IRL-2-DIM	WHITNEY AUDITORIUM STAGE INDEX RAIL

TYPE	DESCRIPTION	MOUNTING	LAMPING	BALLAST(S)/ DRIVER(S)	VOLTS	MANUFACTURER SERIES & NO. *	NOTES
W5	<u>LED PENDANT</u> : 19" DIAMETER X 5" HIGH, TWO-PIECE DIECAST ALUMINUM HOUSING, PRECISION MOLDED MICRO PRISMATIC ACRYLIC LENSES AND BACK REFLECTORS, WIDE DISTRIBUTION, BLACK FINISH, INCLUDE PENDANT SWIVEL KIT	SHORT CONDUIT STEM (ADAPT IF REQ'D)	LED'S 3000K, 80 CRI 3,592 LUMENS 135 LUMENS/WATT L89 @ 100,000 HOURS	INTEGRAL DRIVER 0-10V, 1% DIMMING 27W	120-277V	LITHONIA "VCVL" #VCVL LED-V4-P1-30K-80CRI-T5W- MVOLT-PM-UPL1-DBLXD-SLVRD	WHITNEY AUDITORIUM STAGE (ABOVE LOADING BRIDGE)
X1	<u>LED EXIT SIGN</u> : SINGLE-FACE, DIECAST ALUMINUM HOUSING AND FACEPLATE, STENCIL FACE W/ 6" HIGH RED LETTERS, TEXTURED WHITE FINISH, ARROWS PER PLANS, 4-HOUR NICKEL METAL HYDRIDE BATTERY BACK-UP, BROWNOUT DETECTION, LOW VOLTAGE DISCONNECT, SELF-DIAGNOSTICS	UNIVERSAL	RED LED'S 10-YEAR LIFE	INTEGRAL DRIVER 2.4W	120/277V	ISOLITE "TL2" #TL2-EM-R-1-WH-MTEB-SD	GENERAL USE
X2	<u>LED EXIT SIGN</u> : DOUBLE-FACE, DIECAST ALUMINUM HOUSING AND FACEPLATES, STENCIL FACES W/ 6" HIGH RED LETTERS, TEXTURED WHITE FINISH, ARROWS PER PLANS, 4-HOUR NICKEL METAL HYDRIDE BATTERY BACK-UP, BROWNOUT DETECTION, LOW VOLTAGE DISCONNECT, SELF-DIAGNOSTICS	UNIVERSAL	RED LED'S 10-YEAR LIFE	INTEGRAL DRIVER 2.4W	120/277V	ISOLITE "TL2" #TL2-EM-R-2-WH-MTEB-SD	GENERAL USE
X3	<u>LED EXIT SIGN</u> : SINGLE-FACE, DIECAST ALUMINUM HOUSING AND FACEPLATE, STENCIL FACE W/ 6" HIGH RED LETTERS, TEXTURED BLACK FINISH, ARROWS PER PLANS, 4-HOUR NICKEL METAL HYDRIDE BATTERY BACK-UP, BROWNOUT DETECTION, LOW VOLTAGE DISCONNECT, SELF-DIAGNOSTICS	UNIVERSAL	RED LED'S 10-YEAR LIFE	INTEGRAL DRIVER 2.4W	120/277V	ISOLITE "TL2" #TL2-EM-R-1-BK-MTEB-SD	WHITNEY AUDITORIUM AND STAGE

END OF SECTION 265001

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following types of LED luminaires:

1. Lighting Fixtures.
2. Materials.
3. Finishes.
4. Fixture support.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
1. Arrange in order of luminaire designation.
 2. Include data on features, accessories, and finishes.
 3. Include physical description and dimensions of luminaires.
 4. Include emergency lighting units, including batteries and chargers.
 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 6. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.

- a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.6 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Refer to the Lighting Fixture Schedule on the drawings for the specified fixtures and options.

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Standards:
 - 1. ENERGY STAR certified.
 - 2. California Title 24 compliant.
 - 3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
 - 4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
 - 5. UL Listing: Listed for damp location.
 - 6. Recessed luminaires shall comply with NEMA LE 4.
- C. CRI as indicated on the drawings. CCT as indicated on the drawings.
- D. Rated lamp life of minimum 50,000 hours to L70.
- E. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- F. Internal driver.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- B. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- D. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Owner, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls or Attached to a minimum 20 gauge backing plate attached to wall structural members.
 - 2. Do not attach luminaires directly to gypsum board.
- G. Ceiling-Mounted Luminaire Support:
 - 1. Ceiling mount with minimum two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
 - 2. Pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
 - 3. Ceiling mount with hook mount.
- H. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

END OF SECTION 265119

SECTION 265561 – ELECTRICAL WORK FOR THEATRICAL LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Electrical work associated with the installation of theatrical lighting systems and equipment.

1.2 RELATED SECTIONS

- A. Section 190500 Theatrical Lighting and Controls Basic Requirements.
- B. Section 265565 Theatrical Lighting Miscellaneous Equipment.
- C. Section 265569 Electrical Work for Theatrical Audio/Video.

PART 2 - PRODUCTS

2.1 RACEWAYS, BOXES, BUILDING WIRE, GROUNDING, ETC.

- A. Comply with 260501- Electrical Materials and Equipment.

2.2 THEATRICAL LIGHTING EQUIPMENT AND DEVICES

- A. General: As specified and furnished under Division 19 and as indicated on the Division 19 Drawings.

2.3 THEATRICAL LIGHTING CABLES

- A. General: As specified herein and/or on the Drawings.
- B. Confirmation: Confirm all required wire/cable types with the Division 19 Theatrical Equipment Contractor, prior to ordering cable or commencing work.

PART 3 - EXECUTION

3.1 GENERAL

- A. Summary: In general, Theatrical Lighting systems and equipment are to be furnished by Division 19 and are to be installed and wired by Division 26. Line voltage wire terminations to be performed by Division 26. All low voltage control wiring terminations to be performed by Division 19. See below Responsibility Matrix for specifics.

1. Exception: Provide (furnish and install) all theatrical lighting miscellaneous equipment specified under 265565- Theatrical Lighting Miscellaneous Equipment.
 - B. Scope: Provide all electrical work associated with theatrical lighting systems and equipment as indicated on the Electrical Drawings and as specified herein.
 - C. Preparation: Obtain and review all Theatrical Lighting Product Data, Shop Drawings and manufacturers' installation instructions, and become thoroughly familiar with requirements of same, prior to commencing work. Examine actual equipment to verify proper connection locations and requirements.
 - D. Coordination: Sequence electrical rough-in and wiring to coordinate with the installation and start up schedule and work of Division 19- Theatrical Equipment.
 - E. Protection of Equipment: During installation, and up to the date of System Acceptance, the Division 26 Contractor shall be under obligation to protect the Theatrical Lighting Contractor's finished and unfinished work, and all items furnished by Division 19 to Division 26 for installation by Division 26) against damage and loss. In the event of such damage or loss, the Division 26 Contractor shall replace or repair such work/item at no cost to the Division 19 Contractor.
- 3.2 RACEWAYS, BOXES, WIRE, GROUNDING, ETC.
- A. General: Comply with 260501- Electrical Materials and Equipment.
 - B. Raceways: Provide all raceways required for Theatrical Lighting systems and equipment. This includes all those indicated and/or required for both line voltage power circuits and low voltage control lines.
 - C. Boxes: Unless Theatrical Equipment device/station is furnished with a custom box (confirm with Division 19), provide all necessary pull, junction, outlet and back boxes indicated and required for all Theatrical Lighting devices, control stations, etc.
 - D. Locations: All exact outlet locations are subject to Architect/Engineer's approval.
- 3.3 WIRE AND CABLE INSTALLATION
- A. General: Provide all line voltage and low voltage control wires/cables as indicated and required by Division 19 for satisfactory operation of all Division 19 provided equipment, devices and control stations. At equipment and device boxes, leave slack cables in lengths as required by the Theatrical Lighting Equipment Manufacturer's Installation Technician.
 - B. Line Voltage Power Wiring: Install all line voltage wiring in specified metal raceway, sized as indicated and per NEC. Install all wiring without splices, unless specifically approved.
 - C. Low Voltage Control Wiring (Plenum Rated Cables Only): May be run without raceway only when concealed within interior building construction (e.g. above suspended ceilings), and unless raceway protection is necessary for proper system operation. Run cables together in groups, and away from other electrical lines as much as possible. Neatly

support and secure all cables to building structure (do not droop cables). Securely fasten cables at least every 5 feet and within 12 inches of outlet boxes.

1. All Non-Plenum Rated Cables: Must be installed in metal conduit.
2. Cables to be installed in Unfinished Areas: (E.g. Mechanical, Electrical and Storage Rooms, Whitney Auditorium Stage and Control Booth, all rooms on Ground Floor below the Whitney Auditorium, etc.). Provide conduit protection for all cables installed in these areas.
3. Cables to be Installed on Catwalk Level (Above Whitney Auditorium Ceiling): Provide conduit protection for all cables installed on the Catwalk Level, unless indicated or approved otherwise.

D. For All Low Voltage Control Wiring Required to be Installed in Raceways:

1. Size: All raceways to be sized per NEC, allowing minimum 25% spare fill capacity.
2. Where cable(s) penetrate fire rated barriers, would be left exposed or susceptible to damage, install in specified metal raceway.
3. On Stage Walls and Horizontal Runs Above Stage: All cables running along or up Stage walls, and all cables running overhead above Stage are to be installed in existing and/or new specified metal raceways. Prime and paint (Matte Black) all such new conduits, and all existing conduits remaining which are not already painted Black.

- E. Low Voltage Cable Splices: Install all wiring without splices, unless specifically approved. All splices (if approved) to be made up in outlet or junction boxes. Exposed splices will not be permitted.

3.4 THEATRICAL LIGHTING EQUIPMENT AND DEVICES

- A. General: (For Division 19 furnished equipment required to be installed by Division 26)- Accept equipment and devices from Division 19, and confirm in undamaged condition. Resolve any discrepancies before proceeding. Install equipment and devices per the respective manufacturer's written instructions and as directed by the Theatrical Lighting Contractor.
- B. Coordination: Coordinate the details of equipment and device installation and wiring requirements with Division 19.

3.5 THEATRICAL LIGHTING RESPONSIBILITY MATRIX

- A. General: Responsibility and specific division of work between Division 19 and Division 26 for Theatrical Lighting systems and equipment, and the electrical work related thereto shall be per the following table (see next page):

THEATRICAL LIGHTING SYSTEMS/EQUIPMENT RESPONSIBILITY MATRIX								
ITEM	NOTES	FURNISHED BY	INSTALLED BY	BOX & RACEWAY ROUGH-IN BY	PERMANENT POWER CABLES PROVIDED BY	PERMANENT CONTROL CABLES PROVIDED BY	PERMANENT POWER CABLES TERMINATED BY	PERMANENT CONTROL CABLES TERMINATED BY
RIGGING WORK		DIV. 19	DIV. 19	--	--	--	--	--
LIGHTING CONTROL PANELS	1	DIV. 19	DIV. 26	DIV. 26	DIV. 26	DIV. 26	DIV. 26	DIV. 19
ARCH. LIGHTING CONTROL STATIONS		DIV. 19	DIV. 19	DIV. 26	DIV. 26	DIV. 26	DIV. 26	DIV. 19
LIGHTING CONTROL CONSOLE		DIV. 19	DIV. 19	--	--	--	--	--
STAGE ELECTRIC CONNECTOR STRIPS	2	DIV. 26	DIV. 19/26	DIV. 26	DIV. 26	DIV. 26	DIV. 26	DIV. 19
RECEPTACLE BOXES		DIV. 26	DIV. 26	DIV. 26	DIV. 26	--	DIV. 26	--
GRID IRON J-BOXES (POWER)		DIV. 26	DIV. 26	DIV. 26	DIV. 26	--	DIV. 26	--
GRID IRON J-BOXES (NETWORK & DMX)		DIV. 26	DIV. 26	DIV. 26	--	DIV. 26	--	DIV. 19
THEATRICAL LIGHTING CONTROL STATIONS		DIV. 19	DIV. 26	DIV. 26	--	DIV. 26	--	DIV. 19
THEATRICAL LIGHTING FIXTURES	3,4,5	DIV. 19	DIV. 19	--	--	--	--	--
NOTES								
*	DIV. 19 MEANS THE DIVISION 19 THEATRICAL LIGHTING CONTRACTOR/INTEGRATOR.							
*	DIV. 26 MEANS THE DIVISION 26 ELECTRICAL CONTRACTOR.							
1	INCLUDES RACEWAYS, AND FEEDER AND BRANCH CIRCUIT CONDUCTORS, AND CONNECTING BRANCH CIRCUIT CONDUCTORS AND CONTROL CABLES.							
2	RIGGING/MOUNTING OF CONNECTORS STRIPS TO BE BY DIV 19. ELECTRICAL TO BE AS INDICATED HEREIN.							
3	FIXTURES TO BE LOCATED, CLAMPED AND SAFETIED BY DIV. 19.							
4	FIXTURES TO BE CONNECTED TO 120V POWER RECEPT/PIGTAIL AND DMX BY DIV. 19.							
5	FIXTURES TO BE AIMED, FOCUSED AND SHUTTERED BY DIV. 19.							

END OF SECTION 265561

SECTION 265565 – THEATRICAL LIGHTING MISCELLANEOUS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope of Work: Provide miscellaneous electrical work associated with theatrical lighting systems including: Grid iron boxes, connector strips, receptacle boxes, and other specified electrical or related items.

1.2 RELATED SECTIONS

- A. Section 190500 Theatrical Lighting and Controls Basic Requirements.
- B. Section 265561 Electrical Work for Theatrical Lighting.
- C. Section 265569 Electrical Work for Theatrical Audio/Video.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Shall have continuously engaged in the production of theatrical lighting equipment for at least fifteen years.

1.4 GUARANTEE

- A. Manufacturer's Warranty: Including all parts, labor and travel to replace defective materials and workmanship, for a period of two years.

1.5 SUBMITTALS

- A. Product Data: Manufacturer's descriptive literature for each type of theatrical lighting equipment and accessory to be submitted under this Section.
- B. Shop Drawings:
 - 1. Complete description, specifications and detailed and dimensioned factory drawings and wiring diagrams for all grid iron boxes and connector strips.

PART 2 - PRODUCTS

2.1 GRID IRON JUNCTION BOXES- POWER

- A. Acceptable Manufacturers: ETC; Altman; SSRC.

- B. General: Grid iron junction boxes designed for connection between incoming hard conduit/wire feeds and outgoing multi-conductor cable drops to connector strip terminal boxes located on dead hung or flying pipe battens.
- C. Description: U.L. listed, code gauge, cold rolled steel housing containing terminal strip(s) of appropriate quantity/size for respective circuit terminations, with factory installed ground lugs. Terminal strip shall be of the barriered, screw clamp type for #14-8 AWG wires in quantities as specified, indicated or required. Housing shall be designed for surface mounting. Finish shall be flat black enamel. When cable drops are used, Kellems grips of appropriate size shall be supplied for termination at box, one per drop. Each terminal block phase terminal to be identified as to respective Lighting Control Panel circuit number (and each neutral terminal to be identified same plus "N").
- D. Multi-Conductor Cables: 10-gauge, multi-conductor, 90°C, type "SO" feeder cable, per ASTM D-1679, for connecting stage terminal box runs to the grid iron junction boxes. Provide as required, in sufficient lengths to allow free batten travel to both high and low trim positions without cable conflicts and/or binding. Include Kellems grip strain relief devices properly sized for the respective cable(s), at both cable ends as detailed on the Drawings.

2.2 GRID IRON JUNCTION BOXES- NETWORK/DMX

- A. Acceptable Manufacturers: ETC; Altman; SSRC.
- B. General: Similar to power grid iron junction boxes above, but as required to accommodate two incoming and outgoing Cat-6 network cables with RJ45 jacks for both in and out.

2.3 CONNECTOR STRIPS

- A. Acceptable Manufacturers: ETC #9900 Series; or equal by Altman or SSRC.
- B. General: U.L. listed, 0.125 extruded #6063-T5 aluminum or 18 gauge steel wire-way, 4.75" x 3.375" in cross section in lengths specified, containing terminal strips for feed connections, and wire extending to pigtails terminating in female connectors as specified. Cover sections shall be interlocking and formed of the same aluminum alloy.
- C. Compartments: Separate compartment for line voltage and low voltage wiring.
- D. Length: As indicated on Drawings.
- E. Finish and Identification: Strip finish shall be electrostatic black paint with pigtails identified by adjacent two-inch high white identification numbers on the vertical surface. (Identification on both sides for stage electrics; only on upstage side for front of house electrics.)
- F. Wire: 125°C XLP rated wiring of proper size and quantity to connect the individual outlets to the terminal blocks in circuits of capacity as specified or indicated.

- G. Power Terminal Boxes: NEMA-1 enclosure with screw-on cover, with molded barrier type terminal blocks with tubular screw clamps suitable for connecting multi-conductor feed cables or incoming wire. Two terminals per circuit shall be provided, to accept #14-8 AWG wires.
- H. Network/DMX Terminal Boxes: NEMA-1 enclosure with screw-on cover, in and out RJ-45 network connector jacks.
- I. Pigtails: Unless indicated otherwise, 12" long black type "SO" cable with 2#12 and 1#12 ground conductors.
- J. Pigtail Spacing: 36" unless indicated otherwise.
- K. Pigtail Connectors: All black color, industrial grade, 125V, 20 amp, 2-pin plus ground NEMA L5-20R twist-lock female connector body equal to LeGrand/P&S #L520CBK or Hubbell #HBL2313BK.
- L. Network Outlets/Jacks: RJ45, located as indicated.
- M. DMX-Out Outlets/Jacks: Female 5-pin XLR type.
- N. Mounting Hardware: Include black 7-gauge steel double-pipe hanger brackets equal to ETC Type 26, in quantities as required for maximum 60" bracket spacing along full length of connector strip.
- O. Pipe Battens: Existing and/ or new to be provided under Division 19.

2.4 RECEPTACLE BOXES

- A. Acceptable Manufacturers: ETC; Altman; SSRC.
- B. Description: U.L. Listed, surface mount, 18-gauge steel box with 14-gauge steel cover with black fine-textured powdercoat finish, terminal strips for all required field wiring, and with receptacle(s) as indicated.
- C. Edison Receptacles: Black, duplex, nylon face, 125V, 20A NEMA 5-20R, Industrial Extra Heavy-Duty Grade, P&S #PS5362 series or Hubbell #HBL5352 series.
- D. Twist-Lock Receptacles: Black, single, nylon face, 125V, 20A NEMA L5-20R, Industrial Spec Grade, P&S #L520R series or Hubbell #HBL2310 series.

2.5 IDENTIFICATION

- A. Receptacles and Pigtails: All receptacle box receptacles and connector strip pigtails to be permanently identified (for connector strips, on both the House and Stage sides) with respective Lighting Control Panel circuit number, in 2" high (connector strips) or 1.25" high (receptacle boxes) white lettering.

- B. Network/DMX Outlets: To be clearly identified as to function and respective network patch panel port, etc.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation: Install theatrical lighting miscellaneous equipment, complete with all necessary accessory hangers, clamps, grips, brackets, outlet boxes, and miscellaneous hardware/devices required for a complete installation as recommended by the respective equipment manufacturers and industry standard practices.

3.2 EQUIPMENT MOUNTING AND SUPPORT

- A. General: See Division 19.
- B. Mounting Heights: Confirm all mounting heights.

3.3 GRID IRON JUNCTION BOXES

- A. General: Installation and wiring by Division 26.
- B. Final Power Terminations: By Division 26.
- C. Final Network and DMX Control Terminations: By Division 19.

3.4 CONNECTOR STRIPS

- A. Mounting: By Division 19.
- B. Power Terminal Box Connections: By Division 26.
- C. Network Terminal Box Connections: By Division 19.

3.5 RECEPTACLE BOXES

- A. General: Installation and wiring by Division 26.
- B. Final Power Terminations: By Division 26.

END OF SECTION 265565

SECTION 265569- ELECTRICAL WORK FOR THEATRICAL AUDIO/VIDEO

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Electrical work associated with the installation of theatrical audio and video systems and equipment.

1.2 RELATED SECTIONS

- A. Division 19 - All Sections.
- B. Section 265561 - Electrical Work for Theatrical Audio/Video.

PART 2 - PRODUCTS

2.1 RACEWAYS, BOXES, BUILDING WIRE, GROUNDING, ETC.

- A. Comply with Section 260501- Electrical Materials and Equipment.

2.2 THEATRICAL AUDIO AND VIDEO EQUIPMENT AND DEVICES

- A. General: As specified and furnished under Division 19 and as indicated on the Division 19 Drawings.

2.3 THEATRICAL AUDIO AND VIDEO CABLES

- A. General: As specified herein and/or on the Drawings.
- B. Confirmation: Confirm all required wire/cable types with the Division 19 Theatrical Equipment Contractor, prior to ordering cable or commencing work.

PART 3 - EXECUTION

3.1 GENERAL

- A. Summary: In general, Theatrical Audio and Video systems and equipment are to be furnished by Division 19 and are to be installed and wired by Division 26. Line voltage wire terminations to be performed by Division 26. All low voltage control wiring terminations to be performed by Division 19.

- B. Scope: Provide all electrical work associated with theatrical audio and video systems and equipment as indicated on the Electrical Drawings and as specified herein.
- C. Preparation: Obtain and review all Theatrical Audio and Video Product Data, Shop Drawings and manufacturers' installation instructions, and become thoroughly familiar with requirements of same, prior to commencing work. Examine actual equipment to verify proper connection locations and requirements.
- D. Coordination: Sequence electrical rough-in and wiring to coordinate with the installation and start up schedule and work of Division 19- Theatrical Equipment.
- E. Protection of Equipment: During installation, and up to the date of System Acceptance, the Division 26 Contractor shall be under obligation to protect the Theatrical Audio and Video Contractor's finished and unfinished work, and all items furnished by Division 19 to Division 26 for installation by Division 26) against damage and loss. In the event of such damage or loss, the Division 26 Contractor shall replace or repair such work/item at no cost to the Division 19 Contractor.

3.2 RACEWAYS, BOXES, BUILDING WIRE, GROUNDING, ETC.

- A. Comply with 260501- Electrical Materials and Equipment.
- B. Raceways: Provide all raceways required for Theatrical Audio and Video systems and equipment. This includes all those indicated and/or required for both line voltage power circuits and low voltage control lines.
- C. Boxes: Unless Theatrical Equipment device/station is furnished with a custom box (confirm with Division 19), provide all necessary pull, junction, outlet and back boxes indicated and required for all Theatrical Lighting devices, control stations, etc.
- D. Locations: All exact outlet locations are subject to Architect/Engineer's approval.

3.3 WIRE AND CABLE INSTALLATION

- A. General: Provide all line voltage and low voltage control wires/cables as indicated and required by Division 19 for satisfactory operation of all Division 19 provided equipment, devices and control stations. At equipment and device boxes, leave slack cables in lengths as required by the Theatrical Audio and Video Equipment Manufacturer's Installation Technician.
- B. Line Voltage Power Wiring: Install all line voltage wiring in specified metal raceway, sized as indicated and per NEC. Install all wiring without splices, unless specifically approved.

- C. Low Voltage Control Wiring (Plenum Rated Cables Only), Except Speaker Lines: May be run without raceway only when concealed within interior building construction (e.g. above suspended ceilings), and unless raceway protection is necessary for proper system operation. Run cables together in groups, and away from other electrical lines as much as possible. Neatly support and secure all cables to building structure (do not droop cables). Securely fasten cables at least every 5 feet and within 12 inches of outlet boxes.
 - 1. All Non-Plenum Rated Cables: Must be installed in metal conduit.
 - 2. Cables to be installed in Unfinished Areas: (E.g. Mechanical, Electrical and Storage Rooms, Whitney Auditorium Stage and Control Booth, all rooms on Ground Floor below the Whitney Auditorium, etc.). Provide conduit protection for all cables installed in these areas.
 - 3. Cables to be Installed on Catwalk Level (Above Whitney Auditorium Ceiling): Provide conduit protection for all cables installed on the Catwalk Level, unless indicated or approved otherwise.
- D. For All Audio and Video Systems Low Voltage Wiring Required to be Installed in Raceways:
 - 1. Size: All raceways to be sized per NEC, allowing minimum 25% spare fill capacity.
 - 2. Separation: Provide separate conduit runs for microphone lines and speaker lines. Do not combine in same conduit. Maintain a minimum spacing of 6" from power and lighting circuits.
 - 3. Where cable(s) penetrate fire rated barriers, would be left exposed or susceptible to damage, install in specified metal raceway.
 - 4. On Stage Walls and Horizontal Runs Above Stage: All cables running along or up Stage walls, and all cables running overhead above Stage are to be installed in existing and/or new specified metal raceways. Prime and paint (Matte Black) all such new conduits, and all existing conduits remaining which are not already painted Black.
 - 5. Sound and Video System Cable Splices: (Not permitted).

3.4 THEATRICAL AUDIO AND VIDEO EQUIPMENT AND DEVICES

- A. General: (For Division 19 furnished equipment required to be installed by Division 26)- Accept equipment and devices from Division 19, and confirm in undamaged condition. Resolve any discrepancies before proceeding. Install equipment and devices per the respective manufacturer's written instructions and as directed by the Theatrical Lighting Contractor.
- B. Coordination: Coordinate the details of equipment and device installation and wiring requirements with Division 19.

3.5 GROUNDING

- A. General: Effectively ground all equipment, and conductor and cable shields, to eliminate ground loops, hum, noise, instability, crosstalk, and other impairments.

END OF SECTION 265569

SECTION 270010 - BASIC COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Basic administrative and procedural requirements, and general requirements for communications work, applicable to all Division 27 work.

1.2 GENERAL

- A. Comply with Section 260010 Basic Electrical Requirements.

END OF SECTION 270010

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SECTION 270050 – GENERAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: General requirements, and basic materials and methods applicable for all Division 27 work. Limited scope general construction materials and methods for application with communications installations are also included.

1.2 GENERAL

- A. Comply with 260050 General Materials and Methods.
- B. Comply with 260501 Electrical Materials and Equipment.

END OF SECTION 270050

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SECTION 271001 - TELECOM CABLING SYSTEMS- PATHWAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. The following systems or portions of systems may be depicted or partially depicted on the Drawings but are to be provided separately by the Owner (except as indicated otherwise).

- 1. Telecommunications Cabling System (Patch Panels, Cables, Jacks, Coverplates).

1.2 SCOPE OF WORK BY DIVISION 26, 27

- A. 120 Volt Power: As indicated and required for each above system. Confirm with Owner for requirements not shown.
- B. Outlet/Back Boxes and Conduit Stubs: As indicated on Drawings and as indicated herein.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Conduits, Outlet Boxes, Conductors: Per 260501- Electrical Materials and Equipment.

2.2 TELECOM JACKS AND CABLES

- A. General: (To be provided by the Owner).

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordination: Coordinate and cooperate with the Owner (and Owner's selected Contractors) while performing Division 26, 27 work in same areas requiring "By Owner" work for the above systems. Take care not to damage devices, equipment and wiring for these systems. Perform Division 26, 27 work in such a way to allow reasonable concurrent or subsequent installation of the above systems by the Owner or the Owner's selected Contractors.

- B. 120 Volt Power: Provide all 120 volt power connections and receptacles for the above systems as indicated, and as reasonably anticipated/required by the Owner or Owner's selected Contractor where not indicated. Confirm with Owner or Owner's selected Contractor as to where hardwired connection(s) or receptacle(s) are required and provide accordingly.
- C. Service and Miscellaneous Conduits: Provide as indicated.

3.2 SYSTEMS DEVICES

- A. Systems Ceiling Mounted Devices: Are shown for reference and coordination purposes only. Rough-in and installation of all ceiling mounted devices will be provided by the Owner or Owner's selected contractor(s).
- B. Systems Wall Mounted Devices: In general, provide an outlet or back box and conduit stub for each indicated wall mounted device of the above systems.
- C. Telecom Outlet Boxes: Unless indicated or directed otherwise, recessed, 4" square by 2-1/2" deep, with flush single-gang extension ring. (Prior to commencing work, check with the Owner and the Owner's selected Contractor(s) for the above systems to determine any special outlet/back box requirements, differing from this specified standard outlet box. If larger or special boxes are required, provide accordingly.)
- D. Telecom Conduit Stubs: Minimum 1" EMT, from outlet/back box to accessible ceiling space. For rooms with hard ceilings, extend conduit stub horizontally in ceiling space to nearest room/corridor with an accessible (lay-in) ceiling. For floor and boxes in low height partitions, provide below floor conduit and/or conduit run horizontally in low height partition to nearest full height wall, and then rise through wall up to accessible ceiling space
- E. Conduit Stub Ends: Ream and bush each conduit end.
 - 1. Pull Strings: Provide a nylon pull string for each conduit stub, and secure at each end.

END OF SECTION 271001

SECTION 275111 - EXISTING PUBLIC ADDRESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Description of Work: Modify and expand the existing school communication system as indicated. New equipment to include: central equipment components, speakers; volume controls; back boxes; conduit and wiring; and all miscellaneous appurtenances as required for a complete system.
- B. Removals: Remove certain existing school communication systems speakers in renovation areas as indicated, and salvage to Owner or relocate and reuse, as indicated.

1.2 REFERENCE STANDARDS

- A. All equipment to comply with the latest applicable requirements and standards of NFPA 70, UL 50, the Electronics Industries Association (EIA), and the Federal Communications Commission (FCC).

1.3 SUBMITTALS

- A. Product Data: Manufacturer's descriptive literature for each type of device or equipment to be used on the Project.
- B. Shop Drawings:
 - 1. Complete description and layout of modifications to central equipment rack, clearly indicating all components (if needed).
 - 2. Complete wiring diagram, specifically for this Project, clearly indicating all new/reused speakers, devices and equipment and all interconnecting wiring types and quantities. Show all termination points at central equipment rack.
 - 3. Written description of system operation clearly indicating all system features, options, etc.
- C. Record Drawings: Include with the operation and maintenance data, a complete set of record drawings indicating all equipment, speakers, devices and cables, all accurate per as-built conditions.

1.4 GUARANTEE

- A. Manufacturer's Warranty: Including all parts, labor and travel to replace defective materials and workmanship, for a period of two years.

1.5 COMMUNICATION SYSTEMS CONTRACTOR

- A. The communication system work shall be furnished by and installed under the direction of a qualified Communication System Contractor experienced in the installation, testing and adjusting of communications systems similar to the system specified herein.
- B. The Communication System Contractor shall be an authorized dealer for the existing system and new equipment furnished, shall have a minimum of five year's experience in communications systems installation, and shall guarantee daily on-call service, with response time no more than twelve hours, at the Project Site.
- C. Acceptable Communications System Sub-Contractor: Open Systems Metro, 258 Route 117 By-Pass Road, Bedford Hills, NY 10507, T- 914-241-0057; as approved by the School.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Existing System: Field-verify at School.

2.2 SYSTEM DESCRIPTION

- A. General: Complete, integrated communications system, providing intercom, and selective and all-call program distribution, time signal and public address facilities throughout the building.

2.3 INTERCOM AND PUBLIC ADDRESS SYSTEM CENTRAL EQUIPMENT

- A. General: Modify and expand the central equipment if required to accommodate the new speaker zones. New equipment to include the necessary power supplies, card cages, central control unit components, logic, switching and interface cards, amplifiers, termination boards, and all other components necessary for a complete system.
- B. Existing Equipment Rack: Modify/add as required.
- C. Rack Mount Kits: Provide rack mount kit for each new piece of equipment housed in equipment rack.
- D. Control Components: Digital cards, analog cards, switching cards, telephone interface cards, etc. as required to accommodate system expansion.

- E. Power Amplifiers: Add if required to satisfactorily power all new and existing system speakers and speaker horns simultaneously, with at least 30% spare capacity. Modular power amplifier, 120 or 250 watts RMS power output, less than 2% total harmonic distortion at rated load, frequency response of 30 to 20 Khz +/- 1 dB, output regulation better than 2dB from no load to full load, with built-in protection circuitry, and required outputs.

2.4 ADMINISTRATIVE CONTROL CONSOLES (TYPE "AC")

- A. General: Existing at each building to remain.

2.5 SPEAKERS

- A. Quantity: Per Drawings: Also provide (2) spares for each building.
- B. General: Assembly with speaker, transformer, back box, baffle and mounting supports. Confirm new speakers are compatible with existing system.
- C. Speaker: 8" diameter, dual cone, wide angle sound dispersion, 15-watt power rating, frequency response 60-15,000 Hz, with ceramic magnet and 1" voice coil. Include universal dual voltage line matching transformer, frequency response +/- 1.5 dB from 100-10,000 Hz, with 0.5, 1, 2 and 5 watt taps.
- D. Back Boxes: Nominally 12" diameter round steel housing, suitable for flush mounting 8" diameter speakers, acoustically treated with undercoating and patch jute lining.
- E. Baffles: Nominally 12" round for 8" diameter speakers, steel with beveled edge, screw mount, and baked white semi-gloss enamel finish.
- F. Mounting/Support: Provide all necessary supports, hardware, etc. For each speaker back box to be installed in a "lay-in" type ceiling, provide a T-bar bridge (or equivalent) for distributing weight to T-bar members.

2.6 VOLUME CONTROLS

- A. Quantity: Per Drawings. Also provide (2) spares for each building.
- B. Ten-step auto-transformer type with 3 Db per step and positive "off" position, power handling capability of at least 10 watts, higher where required by number of speakers controlled, and with stainless steel faceplate with engraved dial scale.

2.7 MICROPHONES

- A. (Existing at each building to remain).

2.8 TERMINAL BOARDS/CABINETS

- A. General: As required.

2.9 JUNCTION BOXES

- A. As required, clearly labeled with "PA".

2.10 WIRE/CABLE

- A. General: All final wire sizes, types and counts shall be as determined by the communications system contractor for proper system operation, subject to the following minimum requirements. All cables to be plenum rated.
- B. Speaker Cables: 2-wire, minimum 16 gauge, twisted, shielded.

PART 3 - EXECUTION

3.1 GENERAL

- A. Removals: Remove existing speakers in renovation areas as indicated, and salvage to the Owner. Remove all associated wiring.
- B. Installation: Install, wire and connect all devices and equipment per manufacturers' written instructions and for satisfactory operation. Permanently identify all operating controls, switches, outlets, terminals, connections, etc.

3.2 ADMINISTRATIVE CONSOLES AND MICROPHONES

- A. (Existing to remain).

3.3 SPEAKERS

- A. General: Install all speakers for a secure and vibration free installation. Provide all necessary mounting hardware. Use T-bar bridge for all speakers installed in "lay-in" ceilings. Test each speaker line for proper impedance match before connecting to amplifiers.
- B. Suggested Initial Tap Settings:
 - 1. Corridors: 1.0 watts.
 - 2. Classrooms: 0.5 watts.
 - 3. Elementary School Gym: 1.0 watts.

4. (Or as recommended by Communication System Contractor).

- C. Final Tap Settings: Adjust speaker transformer taps from initial tap settings as required for proper audio level, under actual occupancy conditions.

3.4 WIRING

- A. General: Provide all speaker and miscellaneous cables as required for a complete and fully operational system.
- B. Speaker Zones: Provide separate speaker zone homerun cable for each speaker (generally one speaker per room), except where two or more speakers in same room are shown or indicated connected in which case the speakers shown connected shall be wired as one zone.
- C. Cable Installation: Cable may be run without raceway when concealed within interior building construction. Run communication system cables together in groups, and away from other electrical lines as much as possible. Install cables neatly, in straight lines parallel and perpendicular to building lines. Neatly support and secure all cables to building structure (do not droop cables). Fasten cables at least every 5 feet and within 12 inches of speaker and outlet boxes. All cables to be continuous without splice. Where cable(s) penetrate fire rated barriers, would be left exposed or susceptible to damage, install in raceway.
- D. Splices: Do not splice speaker cables.
- E. Existing Speakers Remaining: Maintain existing connections.

3.5 GROUNDING

- A. Effectively ground all equipment, and conductor and cable shields, to eliminate ground loops, noise pickup and other impairments.

3.6 CONNECTIONS TO TELEPHONE SYSTEMS AND SECURITY SYSTEMS

- A. (Existing to remain). All existing functionality to remain as is.

3.7 SPEAKER ZONE NUMBERING

- A. General: Number each speaker zone, using actual Owner designated room numbers (not construction drawing room numbers), as directed by the Owner.

3.8 SYSTEM CUSTOM PROGRAMMING

- A. Customization of the public address/intercom central equipment control logic, system option selections, station number assignments, station restrictions, etc. shall be performed by the Communication System Contractor so as to comply with all requirements of this section and the Owner's preferences, and shall be included in this contract as follows:
 - 1. Initial programming (for system start-up, as directed by the Architect/Engineer and/or Owner).
 - 2. Second programming (after Owner instruction and prior to final acceptance, as directed by the Architect/Engineer and/or Owner, to comply with the Owner's exact requirements).

3.9 TESTS AND ADJUSTMENTS

- A. General: The Communication System Contractor shall perform all necessary equalization settings and other adjustments as required for optimum operation of the system. The system shall be free from hums and rattles.
- B. Tests: Test each speaker for proper operation. Test each feature of the central equipment for proper operation. Final acceptance testing shall be performed in the presence of the Owner's representative(s) and/or Architect/Engineer, after all equalization settings, tap settings and other adjustments have been made.

3.10 OWNER INSTRUCTION

- A. Instruct the Owner's representative(s), on site, in the operation and maintenance of the system. Explain all system capabilities, features and options. Instructions to be for a minimum of (2) hours and shall be to the Owner's satisfaction.

END OF SECTION 275111

SECTION 280010 - BASIC ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Basic administrative and procedural requirements, and general requirements for electronic safety and security work, applicable to all Division 28 work.

1.2 GENERAL

- A. Comply with 260010 Basic Electrical Requirements.

END OF SECTION 280010

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SECTION 280050 – GENERAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: General requirements, and basic materials and methods applicable for all Division 28 work. Limited scope general construction materials and methods for application with electronic safety and security installations are also included.

1.2 GENERAL

- A. Comply with 260050 General Materials and Methods.
- B. Comply with 260501 Electrical Materials and Equipment.

END OF SECTION 280050

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SECTION 283100 – FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. System smoke detectors.
 - 2. Carbon monoxide detectors.
 - 3. Addressable interface device.

1.2 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.

1.3 SUBMITTALS

- A. Product Data: For each type of product, including finished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire alarm Level III technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

- D. Manufacturer and equipment supplier shall have a minimum of ten years' prior experience in New York State. Equipment supplier shall have 24-hour parts and labor service available with a maximum 4-hour response time. There shall be a minimum of 2 Independent Authorized Distributors within a 50 mile radius of project. Proprietary equipment shall not be acceptable.

1.5 PROJECT CONDITIONS

- A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
- B. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. The existing fire alarm is a Honeywell Gamewell system with an E3 Series control panel. All new fire detection and alarm system components shall be of the same manufacturer and must meet all requirements of the contract documents.
- B. Existing Fire Alarm Vendor Contact Info:

Sean Werlau
Open Systems Metro
swerlau@osmetro.com
(914) 241-0057 - Office
(914) 640-9314 - Mobile
- C. Products for this project shall be of the latest design that has been in service for at least two (2) years, and no more than 4 years. Obsolete or discontinued models are not acceptable.

2.2 SYSTEM SMOKE DETECTORS

A. General Requirements:

1. Comply with UL 268 and FM approved; operating at 24V DC, nominal, Photoelectric type.
2. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
4. Integral Visual-Indicating Light: LED type, indicating detector alarm/power-on status.
5. Thirty (30) mesh insect screen and magnetically activated test.
6. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at FACP for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACP.
 - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at FACP for 15 or 20 deg F per minute.
 - b. Multiple levels of detection sensitivity for each sensor.
 - c. Sensitivity levels based on time of day. Photoelectric Smoke Detectors:
7. Detector address shall be accessible from FACP and shall be able to identify the detector's location within the system and its sensitivity setting.
8. An operator at FACP, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

- D. Duct Smoke Detectors: Photoelectric type complying with UL 268A, 24V DC. (EST SIGA-SD)
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
 4. Duct detector and housing shall be calibrated and adjusted for sensitivity at the manufacturer's factor to U.L. standards. Detector and housing shall be self-compensating for the effect of air velocity, temperature, humidity and atmospheric pressure.
 5. Each duct detector shall be provided with sampling tubes sized according to duct size, air velocity, and installation conditions.
 6. Each duct detector shall be provided with remote alarm LED on a single gang plate, surface or flush mounted.

2.7 CARBON MONOXIDE DETECTORS

- A. General: Carbon monoxide detector listed for connection to fire-alarm system.
1. Mounting: Adapter plate for outlet box mounting.
 2. Testable by introducing test carbon monoxide into the sensing cell.
 3. Detector shall provide alarm contacts and trouble contacts.
 4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.

5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Detector base shall provide a temporal 4 alarm signal.

2.8 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.
4. Devices shall be flush mounted in finished areas and surface mounted with back box in unfinished areas.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts using NFPA 72A Style B (Class B, Two-Wire) circuit supervision. Module responds to polling signals from FACP/Transponder and shall report alarm initiating/supervisory circuit status changes to it.

C. Control Module: Microelectronic module with one (1) individual addressable control relay with double-pole/double-throw (DPDT) contacts rated at two (7.0A) @ 120VAC/28VDC. Module response to control signals from FACP/Transponder.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
- C. Audible Alarm Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- D. Visible Alarm-Indicating Devices: Install adjacent to each alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.
- E. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

- A. Fire alarm pathway and circuit wiring installation shall comply with NEC Article 760.
- B. Where exposed, all fire alarm circuits shall be installed in dedicated EMT conduit.
- C. Pathways above recessed ceilings and in nonaccessible locations may be plenum-rated cable.
- D. All pathways must be independently supported from the structure above.
- E. Where passing through a wall or floor, provide a metal raceway or rigid nonmetallic conduit sleeve.

- F. All penetrations of rated walls and floors shall be properly fire-stopped.

3.4 IDENTIFICATION

- A. Provide an identification nameplate for each equipment cabinet. Nameplates shall correspond with labeling identified in the submittal drawings.
- B. Fire alarm conduit shall be permanently labeled "FIRE ALARM" every 30 feet.
- C. Fire alarm junction boxes shall be painted red.
- D. All initiating and indicating devices shall be labeled with self-adhesive tape with black lettering and identification labeling according to circuit loop and device address/number.
- E. Color code all wiring per recommended standards. Tag all wires in terminal cabinets with tie wrap tags with inked identification.
- F. Install framed instructions in a location visible from FACP.

3.5 GROUNDING

- A. Ground FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to FACP.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 TESTING

- A. The fire alarm system manufacturer or manufacturer's authorized representative shall test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests shall be witnessed by District (Owner), Engineer of Record, and the Fire Department.
- C. The following tests and inspections shall be performed:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72.

- b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 5. System manufacturer shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire alarm system will be considered defective if it does not pass tests and inspections.

END OF SECTION 283100

SECTION 284605 – EXISTING FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Description of Work: Modify existing multiplexed addressable fire alarm system as indicated. New equipment to include: control panel equipment (if required); manual and automatic alarm initiating devices; audible and visual alarm signaling devices; back boxes; conduit, wiring and cable; and all miscellaneous appurtenances as required for a complete system.
- B. Existing Systems to Remain:
 - 1. New Rochelle High School: Siemens "Fire Finder".

1.2 REFERENCE STANDARDS

- A. All equipment and the installation of same shall comply with the latest applicable standards of NFPA and U.L., and requirements of the local Fire Marshall.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's descriptive literature for required all FACP components, each type of device or equipment, and wire/cable to be used on the project.
- B. Shop Drawings:
 - 1. Complete wiring diagram, specifically for this project, for each building, clearly indicating all new and existing alarm initiating, alarm signaling, and control circuits, connections to all fire alarm devices, other electrical systems, and all terminations at Fire Alarm Control Panel.
 - 2. Record Drawings: Include with the operation and maintenance data, a complete set of record drawings indicating all device and circuit numbers, cable types/sizes and routing, and wire counts, all accurate per as built conditions. Include locations for all end-of-line devices.

1.4 FIRE ALARM SYSTEM SUB-CONTRACTOR QUALIFICATIONS

- A. Fire alarm system work shall be furnished and installed by an authorized dealer for the specified equipment, who shall have at least 10 years experience in the installation of similar systems. Sub-contractor shall hold a NYS license to install fire alarm systems and shall be NICET certified.

- B. Acceptable Fire Alarm Sub-Contractor: Open Systems Metro, 258 Route 117 By-Pass Road, Bedford Hills, NY 10507, T- 914-241-0057; as approved by the School.
- C. Manufacturer's and Installers Warranty: Including all parts, labor and travel to replace defective materials and workmanship, including batteries, for a period of two years.
- D. Warranty Call Response: During the warranty period, fire alarm system supplier/installer shall provide a 24/7 available telephone number for immediate service response.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Match existing manufacturer; no substitutes.
- B. Fire Alarm Devices (General): Devices to match respective existing building units, or be newer compatible equivalents.

2.2 SYSTEM

- A. Overview: Control panel is 24 volt, microprocessor based, intelligent, individually addressable/programmable type, Style 4 (Class B) supervised. The system is capable of monitoring and controlling devices on an individual basis. Alarm and control functions to be as indicated in PART 5, and generally match existing.

2.3 FIRE ALARM CONTROL PANEL/ANNUNCIATOR (FACP)

- A. General: Existing to remain.

2.4 FIRE ALARM ANNUNCIATORS

- A. General: Existing to remain.

2.5 FIRE ALARM POWER SUPPLIES

- A. General: Existing to remain.

2.6 ADDRESSABLE INITIATING AND CONTROL DEVICES

- A. Types: Area type smoke detectors, heat detectors, manual stations, relay modules, monitor modules, control modules, etc.
- B. General: Match existing. Provide suitable device mounting box.

2.7 ALARM NOTIFICATION DEVICES

- A. Types: Fire alarm horn/strobes and strobes.
- B. General: Match existing. Provide suitable device mounting box.

2.8 JUNCTION BOXES

- A. As required, and painted red, and marked with "FA".

2.9 WIRE/CABLE

- A. Low Voltage Cable: UL listed, approved for power limited fire protective signaling circuit application, NEC type FPLP, plenum rated, with red jacket. Conductors to be solid copper, color coded, minimum size #16 AWG for communication loop and initiating circuits, minimum size #14 AWG for alarm signaling circuits; larger if necessary to match existing.
- B. 120 Volt Wiring: Complying with 260501- Electrical Materials and Methods.
- C. Requirements: All wire/cable shall be the size and type (e.g. shielded or unshielded) as required by the manufacturer for proper system operation. Verify all wire/cable sizes, types, and quantity requirements with equipment manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation: Install, wire and connect all devices and equipment for satisfactory operation. All wiring at the FACP shall be in wiring harnesses and arranged for easy addition of future wiring. All wires and terminals shall be permanently identified.
- B. Removals: Remove existing fire alarm devices as indicated, and remove all associated wiring, and all other existing wiring no longer in use. Maintain existing system operation throughout the construction period.

3.2 INSTALLATION SUPERVISION

- A. Installation shall be under the supervision of the Fire Alarm Sub-Contractor until Owner acceptance.

3.3 WIRE/CABLE

- A. General: Provide all required system wiring as necessary to connect all new and relocated existing devices.
- B. Low Voltage Cable: May be run without raceway when concealed within interior building construction, unless raceway protection is necessary for proper system operation. Run fire alarm cables together in groups, and away from other electrical lines as much as possible. Neatly support and secure all cables to building structure (do not droop cables). Fasten cables at least every 5 feet and within 12 inches of outlet boxes. All splices to be made up in outlet or junction boxes. Exposed splices will not be permitted.
- C. Conduit Required: Where cable(s) are to be run on exposed ceiling structure, penetrate fire rated barriers, would otherwise be left exposed or susceptible to damage, install in specified raceway.
- D. 120 Volt Wiring: Comply with 260501- Electrical Materials and Methods.

3.4 FIRE ALARM DEVICES

- A. General: Provide as indicated. Connect each device to existing system (initiating/control loop or notification appliance circuit as applicable) as required. Confirm existing circuits have available spare capacity for added devices, taking into account devices being disconnected from the system. Notify Architect/Engineer accordingly.

3.5 RELAY MODULES

- A. Location: Locate in outlet box near associated monitored device where possible (e.g. in accessible above-ceiling spaces). Do not locate in finished public spaces (e.g. corridors and lobbies).
- B. Connections: Connect to existing initiating/control loop and to respective controlled device as indicated or required.
- C. Relay Modules for Fan Shutdown: Modules to shutdown respective fan unit on any building fire alarm condition.

3.6 SYSTEM CUSTOM PROGRAMMING

- A. Customization of the FACP logic and programming, to incorporate new device identification labels and functions, display formats, etc. shall be performed by the manufacturer's representative so as to comply with all requirements of this section, and shall be included in the contract as follows:
 - 1. Initial programming (for system start up, as directed by the Architect/Engineer).

2. Second programming (prior to final acceptance, as directed by the Architect/Engineer, to comply with the Owner's exact requirements).

3.7 SYSTEM TEST

- A. (By Fire Alarm Sub-Contractor). Perform a quality inspection of the final installation and in the presence of the installing contractor and Construction Manager, Owner and Architect/Engineer's representatives, perform a complete functional test of the system. Testing shall include:
 1. Verification of proper operation of existing FACP, FAA(s) relative to system, modifications/additions.
 2. Activation of each new alarm initiating device, and verification of associated auxiliary control functions on an individual device basis.
 3. Verification of proper operation of all alarm signaling circuit devices.
 4. Verification that all custom device labels, messages, etc., are correct.
- B. Obtain a written approval of satisfactory testing and provide a finalization report.

PART 4 - CIRCUIT REQUIREMENTS

4.1 SYSTEM CONFIGURATION

- A. General: All fire alarm devices/equipment shall be connected to the FACP as required for complete and proper operation, whether specifically indicated or not, including:
 1. Alarm Initiating Devices.
 2. Various controlled Devices.

4.2 FIRE ALARM INITIATING LOOPS

- A. General: Use existing loop serving project area. Confirm adequate capacity to do so.

4.3 FIRE ALARM NOTIFICATION CIRCUITS

- A. General: Use existing circuit(s) serving project area. Confirm adequate capacity to do so

4.4 120 VOLT FIRE ALARM CIRCUITS

- A. General: 120 volt circuits for fire alarm equipment to originate at dedicated circuits in indicated panelboard. Provide as indicated and required.

PART 5 - SYSTEM OPERATION REQUIREMENTS

5.1 GENERAL

- A. Confirm and comply with requirements of local Fire Marshall, the Owner, and the following. In general, maintain existing system operation.

5.2 INITIATING/CONTROL LOOPS

- A. General: Maintain existing system operation.

5.3 ALARM NOTIFICATION CIRCUITS

- A. General: Maintain existing system operation.

END OF SECTION 284605

APPENDIX A

TSI drawings (FOR REFERENCE ONLY)

Authored by PureTek Group, dated May 27, 2025

AVL.LEGD

AVL.OL.1

AVL.PLV.1

AVL.PLV.2

AVL.R.1

AVL.PLOT

AUDIO COMPONENTS LEGEND:							
LABEL	QTY	MANUFACTURER	PART NUMBER	DESCRIPTION	GANG REQ.	SIGNAL WIRES*	POWER WIRES*
AVL-101	1	BLUSTREAM	BLS-DA11ABL-WP-US-V2	Bluetooth & Analog Audio Dante® Wall Plate	1	CT.1	
AVL-102	4	BLUSTREAM	BLS-DA22XLR-WP-US	Dante 2+2 XLR Wall Plate (Dual Gang) - US	2	CT.1	
AVL-103	1	RDL	RX-70A	70V to line level for public address		LV.1, MC.1	
AVL-104	15	dB	IS210L	SPEAKER MAINS - ARRAY MAINS MUST BE HUNG BY RIGGERS (NOT PROVIDED BY PURETEK)		SP.1	
AVL-105	8	dB	IS 115S	SPEAKER SUBS - ARRAY SUBS MUST BE HUNG BY RIGGERS (NOT PROVIDED BY PURETEK)		SP.1	
AVL-106	2	Pliant	CRT-900	CrewCom 900MHz Radio Transceiver (mounted within AVL-402 rack)		CT.1	PW.1
AVL-107	1	RF Venue	DFIND9	JUST THE ANTENNA FROM THIS KIT (FOR MOUNTING)		AT.2	PW.1
AVL-108	6	dB	IS 210T	FILL SPEAKERS		SP.1	
AVL-109	9	dB	IS4T	FRONT OF STAGE FILL SPEAKERS		SP.1	
AVL-110	1	Allen and Heath	AH-DLIVE-DLC35	dLive C Class C3500 24 fader Surface, Dual 12" touchscreens, 1 option I/O port		CT.1	PW.1

*CONNECTIONS SHOWN PER INSTANCE

LIGHTING COMPONENTS LEGEND:							
LABEL	QTY	MANUFACTURER	PART NUMBER	DESCRIPTION	GANG REQ.	SIGNAL WIRES*	POWER WIRES*
AVL-201	1	SSRC	SS-ML400-84-72/1P/20/S-1/1P/10-NS	Relay Lighting Control Panel, 84 space 72-Relays, DMX input		CT.1	AC.72
AVL-202	5	Pathway C.	PWINS XLR5M 2RJ45EC CSC5 2RJ45R BL	DMX INPUT Faceplate XLR5M + RJ45	1	CT.2	
AVL-203	12	SSRC	PM-DMX5F	Pipe Mount 1-GANG BOX: DMX OUT		CT.1	
AVL-204		NOT USED					
AVL-205	4	SSRC	SM-2-520D-1-DMX5F	Surface Mount 3-GANG BOX: (2) Dual-Edison + DMX OUT	3	CT.1	AC.1
AVL-206	1	ETC	IONXE20K0US	ION XE 20 12K-US Console with 12,288 Outputs/Parameters W/(2) Touchscreens (P2424HT by Dell)		CP.1	PW.1

*CONNECTIONS SHOWN PER INSTANCE

VIDEO COMPONENTS LEGEND:							
LABEL	QTY	MANUFACTURER	PART NUMBER	DESCRIPTION	GANG REQ.	SIGNAL WIRES*	POWER WIRES*
AVL-301	1	VPX-TC1-PRO	VPX-TC1-PRO	4K60 4:4:4 1Gbps AV-over-IP transceiver box		CP.1	
AVL-302	5	VPX-TC1-WP2-PRO-B	VPX-TC1-WP2-PRO-B	4K60 4:4:4 1Gbps AV-over-IP transceiver wall plate	2	CT.1	
AVL-303	1	Draper	114615CD	LARGE MOTORIZED PROJECTION SCREEN			AC.1 (FROM AVL-305)
AVL-304	1	Barco	R90103722	G62-W14 Black US - body only - 13,600 Lumen Laser Projector		CP.1 HDMI.1	PW.1
AVL-305	1	Draper	121223	LOW VOLT CONTROLLER FOR SCREEN	1	LV.2	AC.1 (IN AND OUT TO AVL-303)

*CONNECTIONS SHOWN PER INSTANCE

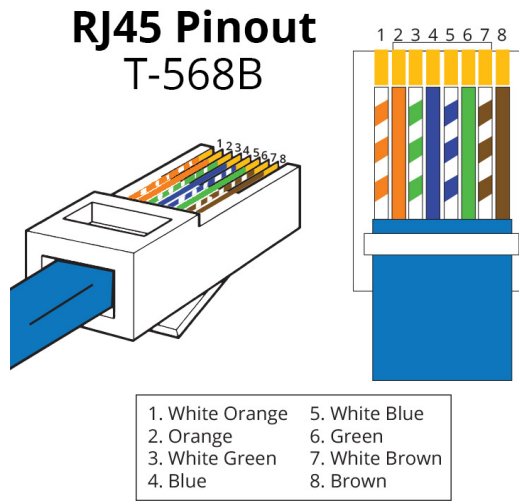
GENERAL COMPONENTS LEGEND:							
LABEL	QTY	MANUFACTURER	PART NUMBER	DESCRIPTION	GANG REQ.	SIGNAL WIRES*	POWER WIRES*
AVL-401	1	unRAVL	PTBB 101	unRAVL Control Rack (USE EXISTING EQUIPMENT RACK ON STAGE)		CT.48 LV.2 XR.2 SP.24	PW.7
AVL-402	1	unRAVL	EXISTING	EXISTING EQUIPMENT RACK - IN BOOTH		CT.23 AT.2 SP.8	PW.4
AVL-403	3	AURORA	RXT-10WM-B	10" wall mount ReAX touch panel control system with serial, I/O, relay, IR, and Ethernet control ports (black)	3	CT.1	
AVL-404	6	Pathway C.	PWWSI VPOE B4 BL	Wall Station Insert, Vignette Power over Ethernet Master, 4-Buttons, Black	1	CT.1	
AVL-405	5	Misc	Misc	4-PORT RJ45 WALLPLATE WITH KEYSTONE CONNECTOR	1	CT.4	
AVL-406	1	TBD	Misc	2-PORT RJ45 WALLPLATE WITH KEYSTONE CONNECTOR	1	CT.2	

*CONNECTIONS SHOWN PER INSTANCE

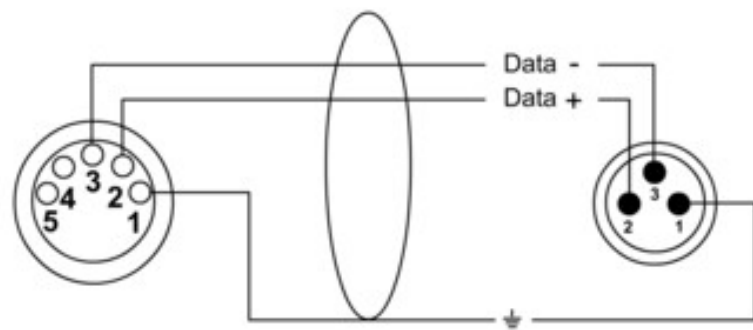
Loose Performance Lighting Fixtures, cables and mounting hardware:					
LABEL	QTY	MANUFACTURER	PART NUMBER	DESCRIPTION	MODE
LT01	40	Chauvet	OVATIONREVEE3	Ovation Reve E-3 LED Ellipsoidal	
LT01A	16	Chauvet	OHDLENS19	19 Degree Ovation HD Lens Tube	
LT01B	24	Chauvet	OHDLENS26	26 Degree Ovation HD Lens Tube	
LT02	15	Chauvet	Ovation Cyc 1FC	Ovation Cyc 1FC Watt LED wash luminaire	
LT03	34	Chauvet	OVATIONE2FC	Ovation E-2 FC LED Ellipsoidal with Manual Zoom	
LT04	36	Chauvet	COLORado1	COLORado 1-Quad Auto-Zoom LED Par Light	
LT05	2	Altman	AFS-500-B	AFS-500, 490 Watt LED Followspot, Black	
	16	Altman	509-18-1	18" Pipe w/ 1 Sliding Tee (w/ 1/2-13 bolt & washer)	
	125	MISC.		5FT XLR 5 Pin DMX Cables	
	20	MISC.		5FT TrueCon to Twist Lock Cables	
	105	MISC.		5FT TrueCon Cables	
	125	MISC.		C-Clamps	
	125	MISC.		Safety Cables	

Work Stage Performance Lighting Fixtures:					
LABEL	QTY	MANUFACTURER	PART NUMBER	DESCRIPTION	DIMMING
LW01	8	Sylvania	62286	1' x 2' - 220 watt - 120/277 volt - 4,000K	NON-DIM
LW01EM	4	Sylvania	63132	1' x 2' - 220 watt - 120/277 volt - 4,000K - Integral EM	NON-DIM
LW02	10	CUSTOM	CUSTOM	Custom Stage Blue Safety Light	PHASE

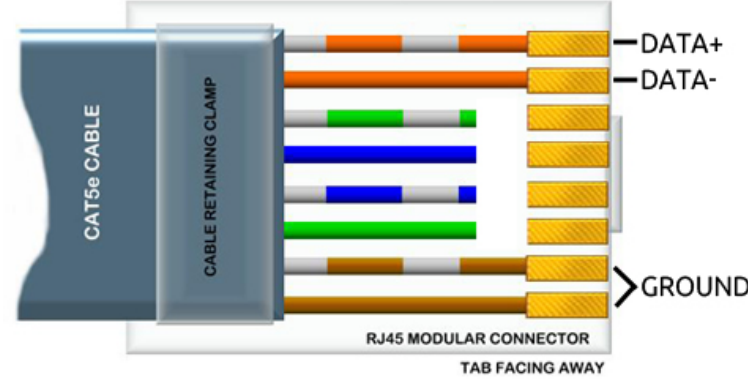
ALL CAT5/6 CABLES TO BE TERMINATED USING STANDARD T-568B



XLR5 AND XLR3 DMX PINOUT



IF USING CAT5/6 CABLE FOR DMX TRANSMISSION UTILIZE STANDARD WIRING BELOW



CABLE LEGEND:

XX.#.X	XX = Cable Type, # = Quantity, X (IN = Input, OT = Output)
CT.#	CAT6A Wire - Belden 10GXW13 or equivalent
CP.#	CAT6 Patch Cable
MC.#	Microphone Wire - Belden 5500FH or equivalent
SP.#	Speaker Wire - Belden 5000UE or equivalent
SPA.#	Speaker Wire - AWG TBD
LV.#	Low Voltage Wire - Belden 5300FE or equivalent
RS232.#	RS232 Control Wire - TBD by TSI
HDMI.#	HDMI Cable - TBD by TSI
AT.#	Antenna Wire - TBD by TSI
SD.#	SDI Video Cable - TBD by TSI
PW.#	Power Cable - TBD by TSI
XR.#	XLR Cable - TBD by TSI
D.#	DMX - Belden 1583A (CAT6) or equivalent
DC.#	0-10V - 18AWG 2 Conductor or equivalent
AC.#	XX AWG 3 conductor or equivalent



1C, 2 Wire + GND, 120V or 208V, 20AMP
(Final Power Requirement TBD)

General Notes

NEW ROCHELLE - WHITNEY HS
LEGEND

3	3/3	06/12/25
2	2/3	05/27/25
No.	Revision/ Issue	Date

Firm Name and Address

PureTek Group

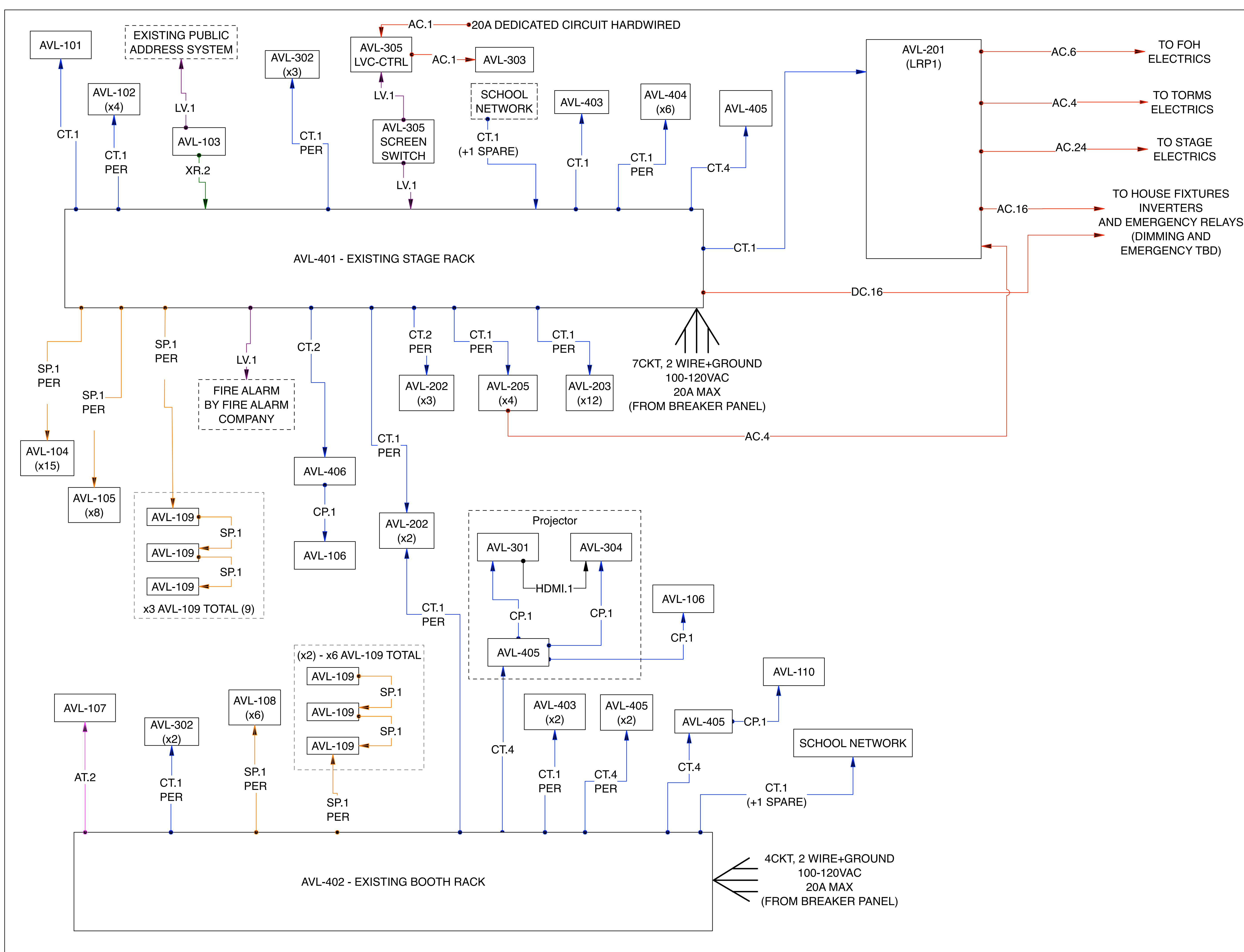
315 Wootton St, Boonton, NJ,
07005

Project Name and Address

NEW ROCHELLE - WHITNEY HS

515 NORTH AVENUE
NEW ROCHELLE, NY 10801

Project	Sheet
NR.W.HS	AVL.LEGD
Date	
05/08/2025	
Scale	
NTS	



General Notes

WHITNEY HS - ONE LINE DIAGRAM

PRODUCTS AND CABLE QTY BASED ON BOM AND LEGEND

EQUIPMENT AND CORRESPONDING WIRE MAY CHANGE BASED ON BOM

DISTANCE OF NETWORK CABLES NOT TO EXCEED 328FT OR 100 METERS

SIZE OF ALL LINE VOLTAGE WIRING APPROPRIATELY

ALL DATA CONNECTIONS TO BE RJ45 CONNECTIONS USE THE STANDARD T568B STANDARD PINOUT

ALL WIRES AND CONNECTIONS MUST BE LABELED ACCORDINGLY AND CLEARLY

REUTILIZE LINE VOLTAGE CIRCUIT RUNS TO STAGE ELECTRICS WHEREVER POSSIBLE (SUBJECT TO CODE COMPLIANCE AND CONDITION OF EXISTING WIRING - EC TO DETERMINE IN FIELD)

No.	Revision/Issue	Date
2	2/2	06-12-2025
1	1/2	05-27-2025

Firm Name and Address

PureTek Group

315 Wootton Street,

Suite L,

Boonton, NJ, 07005

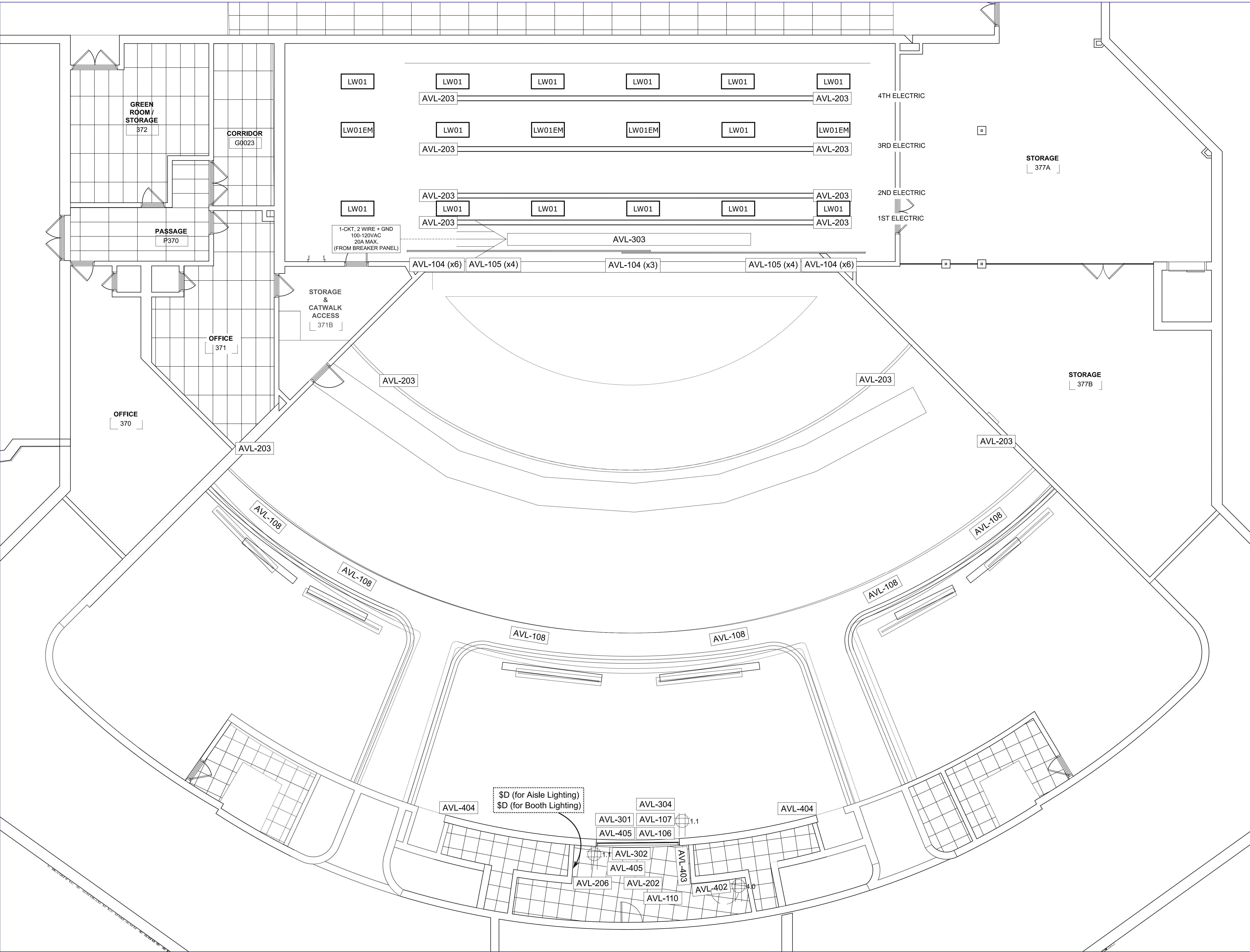
Project Name and Address

Whitney HS

265 Clove Rd,

New Rochelle, NY 10801

Project	WHITNEY HS	Sheet	AVL.OL.1
Date	05-08-2025		
Scale	NO SCALE		



General Notes

PureTek
GROUP

NEW ROCHELLE WHITNEY HS
PLAN.VIEW FLOOR 2

USE LEGEND FOR
REFERENCE.

QUAD RECEPTACLE:
X(NUMBER OF
CIRCUITS).Y(NUMBER
OF QUAD BOXES)

X.Y

2	2/1	05/27/25
No.	Revision/Issue	Date

Firm Name and Address

PureTek Group

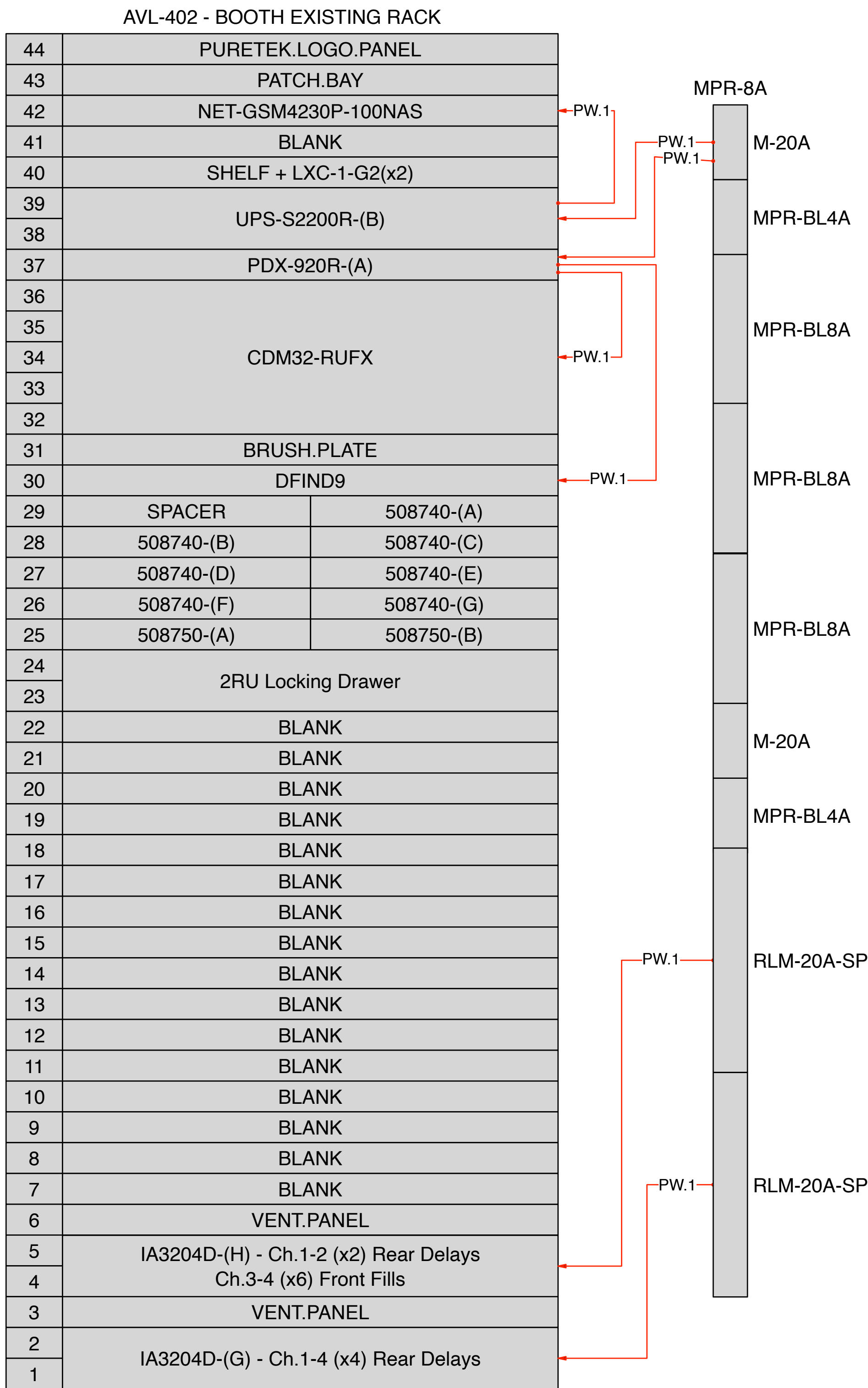
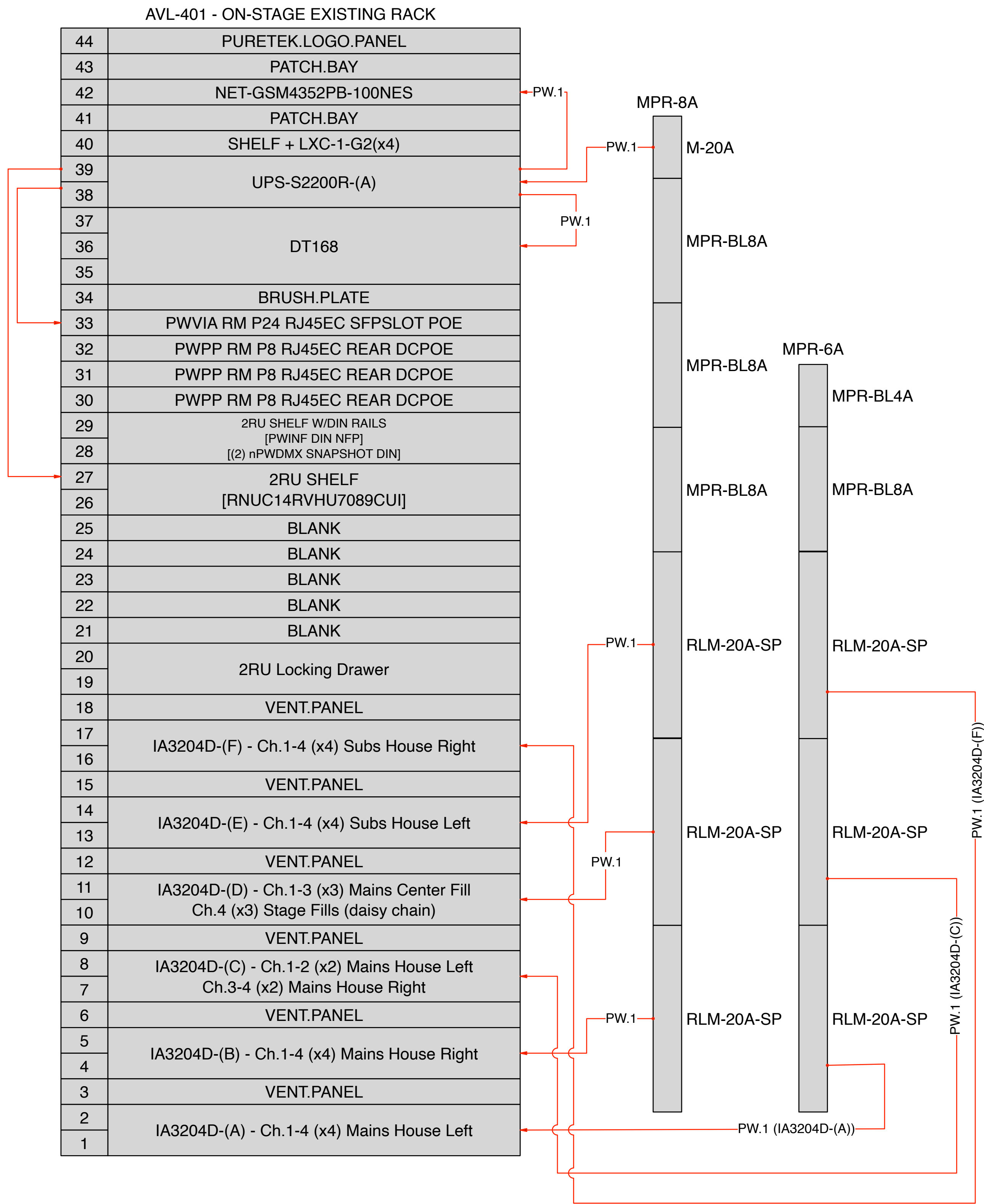
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Boonton, NJ, 07005

Project Name and Address

NEW ROCHELLE WHITNEY HS

265 Clove Rd,
New Rochelle,
NY, 10801

Project NR.W.HS.AUD	Sheet AVL.PLV.2
Date 05/07/2025	
Scale NTS	



General Notes

PureTek

GROUP

WHITNEY HS - RACK LAYOUT

PRODUCTS AND CABLE QTY
BASED
ON BOM AND LEGEND

EQUIPMENT AND
CORRESPONDING
WIRE MAY CHANGE BASED ON
BOM

DISTANCE OF NETWORK
CABLES
NOT TO EXCEED 328FT OR 100
METERS

SIZE OF ALL LINE VOLTAGE
WIRING
APPROPRIATELY

ALL DATA CONNECTIONS TO
BE RJ45 CONNECTIONS USE
THE STANDARD T568B
STANDARD PINOUT

ALL WIRES AND CONNECTIONS
MUST BE LABELED
ACCORDINGLY AND CLEARLY

REUTILIZE LINE VOLTAGE
CIRCUIT
RUNS TO STAGE ELECTRICS
WHEREVER POSSIBLE
(SUBJECT TO CODE
COMPLIANCE AND CONDITION
OF EXISTING WIRING - EC TO
DETERMINE IN FIELD

1	1/1	05-08-2025
No.	Revision/Issue	Date

Firm Name and Address

PureTek Group

315 Wootton Street,

Suite L,

Boonton, NJ, 07005

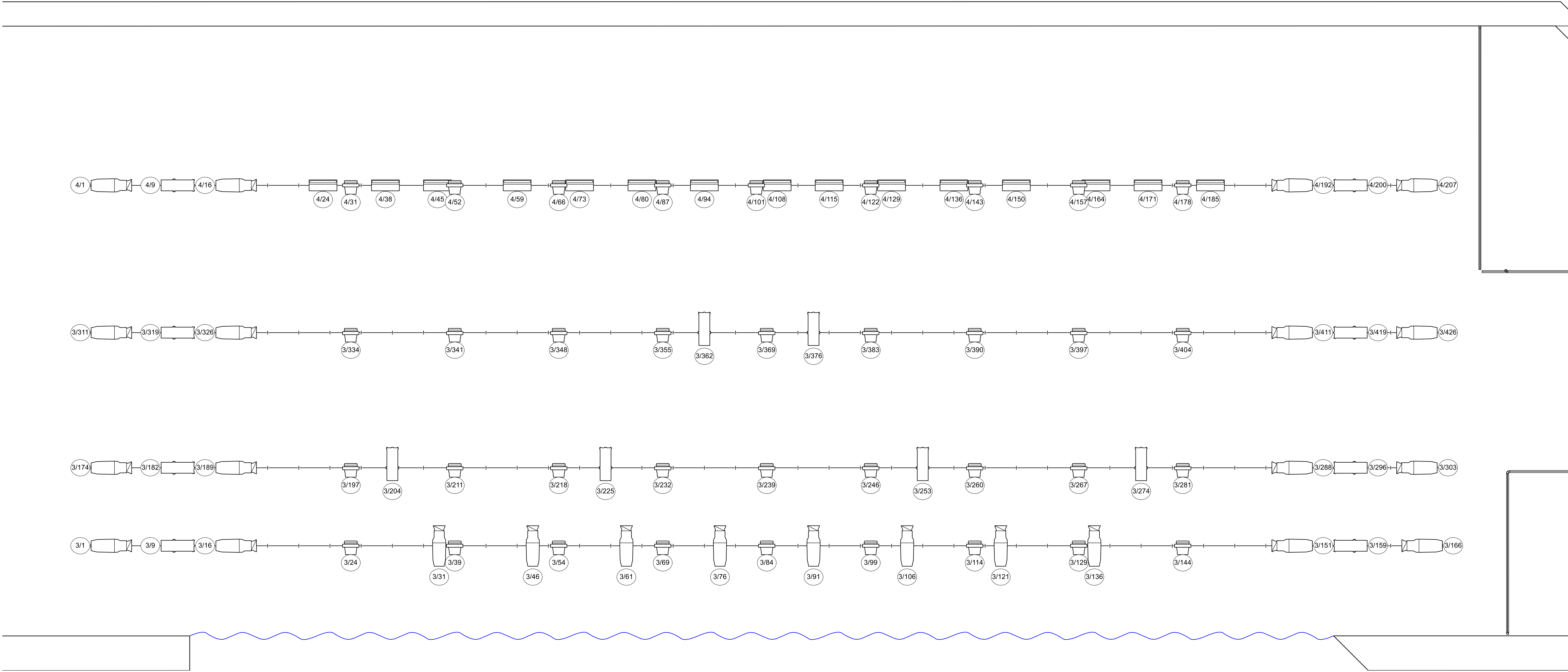
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Whitney HS

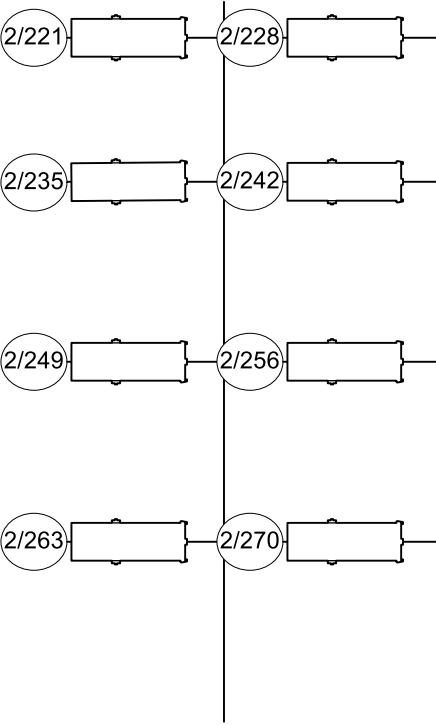
265 Clove Rd,

New Rochelle, NY 10801

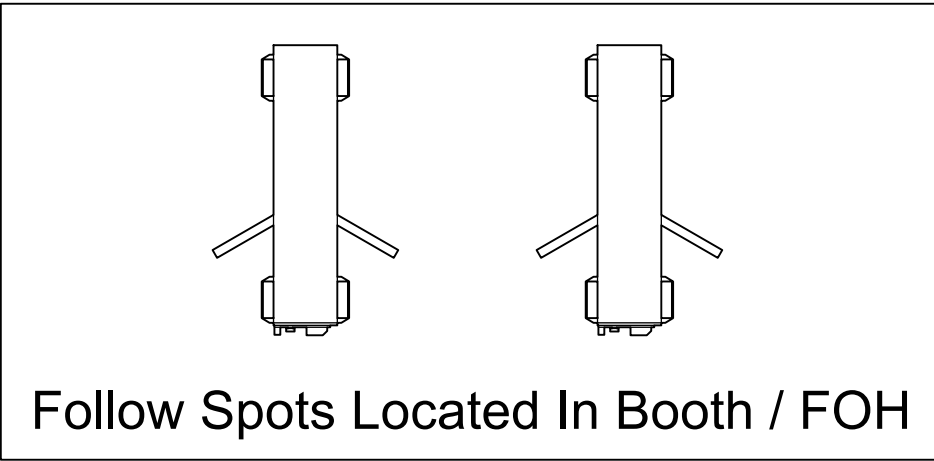
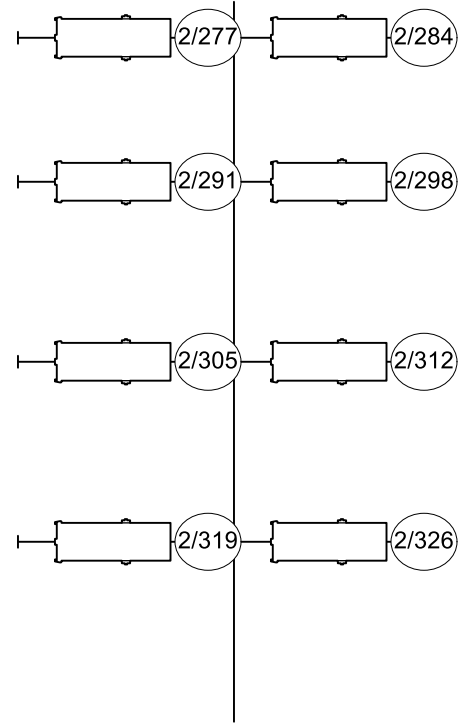
Project	Sheet
WHITNEY HS	AVL.R.1
Date	
05-08-2025	
Scale	
NO SCALE	



House Left Boom



House Right Boom



Follow Spots Located In Booth / FOH

General Notes

PureTek

GROUP

NEW ROCHELLE - WHITNEY HS

THEATRICAL LIGHTING PLOT

Key

19° Ovation
Reve E-3
Ch Mode - 12ch
LT01A

26° Ovation
Reve E-3
Ch Mode - 12ch
LT01B

Ovation Cyc 1
FC
Ch Mode - 7ch
LT02

Ovation E-2
FC Zoom
Ch Mode - 7ch
LT03

COLORado1
Zoom Par
Ch Mode - 9ch
LT04

Altman Followspot
LT05

Legend

Channel

Universe / Address

2	2/1	05/27/25
No.	Revision/ Issue	Date

Firm Name and Address

PureTek Group

315 Wootton St, Boonton, NJ,
07005

Project Name and Address

NEW ROCHELLE - WHITNEY HS

515 NORTH AVENUE
NEW ROCHELLE, NY 10801

Project

NR.W.HS

Date

05/08/2025

Scale

NTS

Sheet

LT.PLOT

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