

PROJECT MANUAL

Mercy Northwest Arkansas Oncology-Surgery Renovation at Hwy 102

3101 SE 14th Street
Bentonville, AR 72712

PROJECT NUMBER: H AR MRCY 25100

ISSUE DATE: 01/09/2026



**SECTION 00 01 01
PROJECT TITLE PAGE**

PROJECT MANUAL

FOR

MERCY NWA ONCOLOGY-SURGERY RENOVATION AT HWY 102

3101 SE 14TH STREE

BENTONVILLE, AR 72712

DATE: 01/07/2026

PREPARED BY:

HFG ARCHITECTURE

END OF SECTION 00 01 01

**SECTION 00 01 03
DESIGN TEAM**

PART 1 GENERAL

SECTION INCLUDES

Identification of project team members and their contact information.

OWNER:

- A. Name: Mercy Hospital Northwest Arkansas
1. Address: 2710 S. Rife Medical Lane.
 2. City: Rogers.
 3. State: Arkansas.
 4. Zip Code: 72758.

Primary Contact: All correspondence from the Contractor to the Architect will be through this party, unless alternate arrangements are mutually agreed upon at preconstruction meeting.

1. Title: Regional Director, Mercy Planning, Design, and Construction.
2. Name: Jayne Fry.
3. Email: Jayne.Fry@Mercy.net.

CONSULTANTS:

Architect: Design Professional of Record. All correspondence from the Contractor regarding construction documents authored by Architect's consultants will be through this party, unless alternate arrangements are mutually agreed upon at preconstruction meeting.

1. Company Name: HFG Architecture.
 - a. Address: 5417 W. Pinnacle Pointe Dr., Suite 404, Rogers, AR 72758.
 - b. Telephone: 479-448-4099 (office); 479-644-5615 (mobile - preferred).
2. Primary Contact:
 - a. Title: Senior Healthcare Architect/Project Manager.
 - b. Name: David Londagin.
 - c. Email: DavidL@hfgarchitecture.com.Secondary Contact:
 - a. Title: Senior Design Professional.
 - b. Name: Sarah Rajan.
 - c. Email: SarahR@hfgarchitecture.com.

Interior Design Consultant:

1. Company Name: HFG Architecture.
2. Primary Contact:
 - a. Title: Interior Designer.
 - b. Name: Caitlin Cox.
 - c. Email: CaitlinC@hfgarchitecture.com.

Structural Engineering Consultant:

1. Company Name: IMEG.
 - a. Address: 15 Sunnen Drive, Suite 104, St. Louis, MO 63143.
 - b. Telephone: 314-951-2516.
2. Primary Contact:
 - a. Title: Senior Structural Engineer.
 - b. Name: Chad Schrand.
 - c. Email: Chad.M.Schrand@imegcorp.com.

Mechanical Engineering Consultant - Plumbing:

Company Name: IMEG.

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Address: 15 Sunnen Drive, Suite 104, St. Louis, MO 63143.

Telephone: 314-951-2516.

Primary Contact:

Title: Mechanical Project Engineer.

Name: Rober Eshelman.

Email: Robert.E.Eshelman@imegcorp.com.

A. Mechanical Engineering Consultant - HVAC:

1. Company Name: IMEG.

a. Address: 15 Sunnen Drive, Suite 104, St. Louis, MO 63143.

b. Telephone: 314-951-2516.

2. Primary Contact:

a. Title: Mechanical Project Engineer.

b. Name: Robert Eshelman.

c. Email: Robert.E.Eshelman@imegcorp.com.

B. Electrical Engineering Consultant:

1. Company Name: IMEG.

a. Address: 15 Sunnen Drive, Suite 104, St. Louis, MO 63143.

b. Telephone: 314-951-2516.

2. Primary Contact:

a. Title: Senior Electrical Engineer.

b. Name: Steve Wiegers.

c. Email: Steve.J.Wiegers@imegcorp.com.

3. Secondary Contact:

a. Title: Electrical Designer

b. Name: Cecilia Fugaro

c. Email: Cecilia.P.Fugaro@imegcorp.com

C. Technology Engineer Consultant:

1. Company Name: IMEG.

a. Address: 15 Sunnen Drive, Suite 104, St. Louis, MO 63143.

b. Telephone: 314-951-2516.

2. Primary Contact:

a. Title: Technology Project Designer.

b. Name: Scott B. Thomas.

c. Email: Scott.B.Thomas@imegcorp.com.

CONSTRUCTION MANAGER:

A. Company Name: Flintco.

1. Address: 184 Fantinel Dr., Springdale, AR 72762.

2. Telephone: 479-750-4565.

B. Primary Contact:

1. Title: Project Director.

2. Name: Justin Stoverink.

3. Email: jstoverink@flintco.com.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 00 01 03

**SECTION 00 01 07
SEALS PAGE**

DRAWINGS:

THE FOLLOWING DRAWINGS HAVE BEEN PREPARED UNDER MY SUPERVISION AND MY SEAL HAS BEEN INDIVIDUALLY AFFIXED TO THESE DOCUMENTS: SEE SHEET INDEX ON DRAWINGS.

SPECIFICATIONS:

THE FOLLOWING SPECIFICATIONS HAVE BEEN PREPARED UNDER MY SUPERVISION AND MY SEAL AFFIXED BELOW APPLIES TO THESE SECTIONS: SEE PROJECT MANUAL TABLE OF CONTENTS.

NON-RESPONSIBILITY:

I DISCLAIM ANY RESPONSIBILITY FOR ALL OTHER TECHNICAL SUBMISSIONS RELATING TO OR INTENDED TO BE USED FOR ANY PART OR PARTS OF THE ARCHITECTURAL OR ENGINEERING PROJECT

END OF SECTION 00 01 07

**SECTION 00 01 10
TABLE OF CONTENTS**

PROCUREMENT AND CONTRACTING REQUIREMENTS

DIVISION 00 -- PROCUREMENT AND CONTRACTING REQUIREMENTS

- 00 01 01 - Project Title Page
- 00 01 03 - Design Team
- 00 01 07 - Seals Page
- 00 01 10 - Table of Contents
- 00 01 15 - List of Drawing Sheets

SPECIFICATIONS

DIVISION 01 -- GENERAL REQUIREMENTS

- 01 10 00 - Summary
- 01 23 00 - Alternates
- 01 25 00 - Substitution Procedures
- 01 30 00 - Administrative Requirements
- 01 32 16 - Construction Progress Schedule
- 01 35 53 - Security Procedures
- 01 40 00 - Quality Requirements
- 01 41 00 - Regulatory Requirements
- 01 42 16 - Definitions
- 01 45 33 - Code-Required Special Inspections
- 01 50 00 - Temporary Facilities and Controls
- 01 55 00 - Vehicular Access and Parking
- 01 58 13 - Temporary Project Signage
- 01 60 00 - Product Requirements
- 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions
- 01 70 00 - Execution and Closeout Requirements
- 01 74 19 - Construction Waste Management and Disposal
- 01 78 00 - Closeout Submittals
- 01 79 00 - Demonstration and Training
- 01 91 13 - General Commissioning Requirements

DIVISION 02 -- EXISTING CONDITIONS

- 02 41 00 - Demolition

DIVISION 03 -- CONCRETE

- 03 05 16 - Underslab Vapor Barrier - Stego Industries
- 03 30 00 - Cast-in-Place Concrete - See Structural Drawings

DIVISION 04 -- MASONRY (NOT USED)

DIVISION 05 -- METALS

- 05 12 00 - Structural Steel Framing - See Structural Drawings

05 50 00 - Metal Fabrications

05 51 33 - Metal Ladders

DIVISION 06 -- WOOD, PLASTICS, AND COMPOSITES

06 10 00 - Rough Carpentry

06 41 16 - Plastic Laminate Casework

DIVISION 07 -- THERMAL AND MOISTURE PROTECTION

07 62 00 - Sheet Metal Flashing and Trim

07 72 00 - Roof Accessories

07 84 00 - Firestopping

07 92 00 - Joint Sealants

DIVISION 08 -- OPENINGS

08 12 13 - Hollow Metal Frames

08 14 16 - Flush Wood Doors

08 30 00 - Clean Room Doors and Windows

08 31 00 - Access Doors and Panels

08 33 13 - Coiling Counter Doors

08 42 29 - Automatic Entrances

08 43 13 - Aluminum-Framed Storefronts

08 71 00 - Door Hardware

08 80 00 - Glazing

08 87 23 - Safety and Security Films

DIVISION 09 -- FINISHES

09 05 61 - Common Work Results for Flooring Preparation

09 21 16 - Gypsum Board Assemblies

09 30 00 - Tiling

09 51 00 - Acoustical Ceilings

09 65 00 - Resilient Flooring

09 68 13 - Tile Carpeting

09 90 00 - Painting and Coating - Healthcare Facility Guide Specification - Sherwin-Williams

DIVISION 10 -- SPECIALTIES

10 21 16 - Cultured Marble Tub and Shower Components

10 21 23 - Cubicle Curtains and Track

10 26 00 - Wall and Door Protection

10 44 00 - Fire Protection Specialties

DIVISION 11 -- EQUIPMENT (NOT USED)

DIVISION 12 -- FURNISHINGS

12 24 00 - Window Shades

DIVISION 13 -- SPECIAL CONSTRUCTION (NOT USED)

DIVISION 14 -- CONVEYING EQUIPMENT (NOT USED)

DIVISION 21 -- FIRE SUPPRESSION

- 21 05 00 - Basic Fire Suppression Requirements
- 21 05 05 - Fire Suppression Demolition for Remodeling
- 21 05 29 - Fire Suppression Supports and Anchors
- 21 05 50 - Seismic Requirements for Equipment and Supports
- 21 05 53 - Fire Suppression Identification
- 21 13 02 - Fire Protection Performance Based Design

DIVISION 22 -- PLUMBING

- 22 05 00 - Basic Plumbing Requirements
- 22 05 05 - Plumbing Demolition for Remodeling
- 22 05 29 - Plumbing Supports and Anchors
- 22 05 53 - Plumbing Identification
- 22 07 19 - Plumbing Piping Insulation
- 22 08 00 - Commissioning of Plumbing
- 22 10 00 - Plumbing Piping
- 22 10 30 - Plumbing Specialties

DIVISION 23 -- HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

- 23 05 00 - Basic HVAC Requirements
- 23 05 05 - HVAC Demolitions for Remodeling
- 23 05 13 - Motors
- 23 05 29 - HVAC Supports and Anchors
- 23 05 50 - Seismic Requirements for Equipment and Supports
- 23 05 53 - HVAC Identification
- 23 05 93 - Testing, Adjusting, and Balancing
- 23 07 13 - Ductwork Insulation
- 23 07 19 - HVAC Piping Insulation
- 23 08 00 - Commissioning of HVAC
- 23 09 00 - Controls
- 23 09 13 - Instrumentation
- 23 09 20 - Venturi Valve Airflow Control System
- 23 21 00 - Hydronic Piping
- 23 21 16 - Hydronic Specialties
- 23 21 23 - HVAC Pumps
- 23 31 00 - Ductwork
- 23 33 00 - Ductwork Accessories
- 23 34 16 - Centrifugal Fans
- 23 36 00 - Air Terminal Units

- 23 37 00 - Air Outlets and Inlets
- 23 72 00 - Energy Recovery Equipment
- 23 74 13 - Rooftop Modular Air Handling Units
- 23 82 00 - Terminal Heat Transfer Units
- 23 82 16 - Air Coils
- 23 84 13 - Humidifiers

DIVISION 26 -- ELECTRICAL

- 26 05 00 - Basic Electrical Requirements
- 26 05 05 - Electrical Demolition for Remodeling
- 26 05 13 - Wire and Cable
- 26 05 26 - Grounding and Bonding
- 26 05 27 - Supporting Devices
- 26 05 33 - Conduit and Boxes
- 26 05 35 - Surface Raceways
- 26 05 48 - Seismic Requirements for Equipment and Supports
- 26 05 53 - Electrical Identification
- 26 08 01 - Commissioning of Electrical
- 26 09 33 - Lighting Control Systems
- 26 27 26 - Wiring Devices
- 26 28 16 - Disconnect Switches
- 26 29 23 - Variable-Frequency Drives
- 26 51 19 - LED Lighting

DIVISION 27 -- COMMUNICATIONS

- 27 05 00 - Basic Communications Systems Requirements
- 27 05 03 - Through Penetration Firestopping
- 27 05 05 - Technology Demolition for Remodeling
- 27 05 28 - Interior Communication Pathways
- 27 05 53 - Identification for Communication Systems
- 27 11 00 - Communications Equipment Rooms (CER)
- 27 13 00 - Backbone Cabling Requirements
- 27 15 00 - Horizontal Cabling Requirements
- 27 17 10 - Testing

DIVISION 28 -- ELECTRONIC SAFETY AND SECURITY

- 28 05 00 - Basic Electronic Safety and Security System Requirements
- 28 13 00 - Electronic Access Control
- 28 31 01 - Fire Alarm and Detection Systems Addressable

END OF SECTION 00 01 10

SECTION 00 01 15
LIST OF DRAWING SHEETS

GENERAL

- G-001 TITLE SHEET**
- G-005 PARTITION TYPES**
- G-101 OVERALL BUILDING LIFE SAFETY PLAN**
- G-101.1 LIFE SAFETY PLAN - INFUSION AND LAB**
- G-102 ADA/ANSI ACCESSIBILITY STANDARDS**
- G-103 ADA/ANSI ACCESSIBILITY STANDARDS**

ARCHITECTURAL

- A-102 DEMOLITION PLAN**
- A-103 FLOOR PLAN - DIMENSIONS**
- A-104 FLOOR PLAN - TAGS**
- A-120 REFLECTED CEILING PLAN**
- A-121 HORIZONTAL ACOUSTICAL ASSEMBLY PLAN**
- A-130 ROOF PLAN & DETAILS**
- A-601 DOOR INFORMATION**
- I-110 FINISH & WALL PROTECTION PLAN**
- I-111 FINISH LEGEND**
- I-120A EQUIPMENT PLAN - INFUSION**
- I-120B EQUIPMENT PLAN - LAB & SCHEDULE**
- I-201 INTERIOR ELEVATIONS**
- I-202 INTERIOR ELEVATIONS**

MECHANICAL

- P-000 PLUMBING COVER SHEET**
- P-100A UNDER FLOOR DEMOLITION PLAN - PLUMBING - INFUSION**
- P-100C UNDER FLOOR DEMOLITION PLAN - PLUMBING - SURGERY**
- P-101A LEVEL 01 DEMOLITION PLAN - PLUMBING - INFUSION**
- P-101B UNDERFLOOR & LEVEL 01 DEMOLITION & NEW PLANS - PLUMBING - LAB**
- P-101C LEVEL 01 DEMOLITION PLAN - PLUMBING - SURGERY**
- P-200A UNDERFLOOR PLAN - PLUMBING - INFUSION**
- P-201A LEVEL 01 PLAN - PLUMBING - INFUSION**
- P-201C LEVEL 01 PLAN - PLUMBING - SURGERY**
- P-300 PLUMBING ENLARGED PLANS**
- P-400 PLUMBING DETAILS - 1**
- P-401 PLUMBING DETAILS - 2**

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P-500 PLUMBING DIAGRAMS - 1
P-501 PLUMBING DIAGRAMS - 2
P-502 PLUMBING DIAGRAMS - 3
P-600 PLUMBING SCHEDULES

PIPING

H-000 PIPING COVER SHEET
H-101A LEVEL 01 DEMOLITION PLAN - PIPING - INFUSION
H-101C LEVEL 01 DEMOLITION - PIPING - SURGERY
H-102 ROOF PLAN - PIPING - INFUSION
H-201A LEVEL 01 PLAN - PIPING - INFUSION
H-201C LEVEL 01 PLAN - PIPING - SURGERY
H-400 PIPING DETAILS
H-401 PIPING DETAILS
H-600 PIPING SCHEDULES

FIRE PROTECTION

F-000 FIRE PROTECTION COVER SHEET
F-101A LEVEL 01 DEMOLITION PLAN - FIRE PROTECTION - INFUSION
F-201A LEVEL 01 PLAN - FIRE PROTECTION - INFUSION
F-201B LEVEL 01 PLAN - FIRE PROTECTION - LAB
F-400 FIRE PROTECTION DETAILS

VENTILATION

V-000 VENTILATION COVER SHEET
V-101A LEVEL 01 DEMOLITION PLAN - VENTILATION - INFUSION
V-101B LEVEL 01 DEMOLITION & NEW PLANS - VENTILATION - LAB
V-102 ROOF PLAN - VENTILATION - INFUSION
V-201A LEVEL 01 PLAN - VENTILATION - INFUSION
V-300 VENTILATION ENLARGED PLAN
V-400 VENTILATION DETAILS
V-401 VENTILATION DETAILS
V-402 VENTILATION DETAILS
V-403 VENTILATION DETAILS
V-404 VENTILATION DETAILS
V-600 VENTILATION SCHEDULES

ELECTRICAL

- E-000 ELECTRICAL COVER SHEET**
- E-001 ELECTRICAL LIGHTING & SYSTEMS COVER SHEET**
- E-101 LEVEL 01 OVERALL PLAN - ELECTRICAL**
- E-102 ROOF PLAN - POWER - INFUSION**
- E-111A LEVEL 01 DEMOLITION PLAN - LIGHTING - INFUSION**
- E-121A LEVEL 01 DEMOLITION PLAN - POWER - INFUSION**
- E-131A LEVEL 01 DEMOLITION PLAN - SYSTEMS - INFUSION**
- E-141B LEVEL 01 DEMOLITION & NEW PLANS - ELECTRICAL - LAB**
- E-211A LEVEL 01 PLAN - LIGHTING - INFUSION**
- E-221A LEVEL 01 PLAN - POWER - INFUSION**
- E-231A LEVEL 01 PLAN - SYSTEM - INFUSION**
- E-300 ELECTRICAL ENLARGED PLANS**
- E-400 ELECTRICAL DETAILS**
- E-600 ELECTRICAL SCHEDULES**
- E-700 ELECTRICAL PANEL SCHEDULES**

TECHNOLOGY

- T-000 TECHNOLOGY COVER SHEET**
- T-101A LEVEL 01 DEMOLITION PLAN - TECHNOLOGY - INFUSION**
- T-101B LEVEL 01 DEMOLITION & NEW PLANS - TECHNOLOGY - LAB**
- T-201A LEVEL 01 PLAN - TECHNOLOGY - INFUS**
- T-300 TECHNOLOGY ENLARGED PLANS**
- T-400 TECHNOLOGY DETAILS**
- T-500 TECHNOLOGY DIAGRAMS**
- T-600 TECHNOLOGY SCHEDULES**

END OF SECTION 00 01 15

**SECTION 01 10 00
SUMMARY**

PART 1 GENERAL

1.01 PROJECT

- A. Project Name: Mercy NWA Oncology-Surgery Renovation at Hwy 102.
- B. Owner's Name: Mercy Northwest Arkansas Communities.
- C. Architect's Name: HFG Architecture.
- D. Additional Project contact information is specified in Section 00 01 03 - DESIGN TEAM.
- E. The Project consists of the alteration , including architectural, structural, mechanical, and electrical renovation of an existing multipurpose space into a new oncology infusion clinical space and USP 797/800 compounding pharmacy. An existing non-operational laboratory area will be modestly renovated into operational laboratory space to support oncology infusion.

1.02 CONTRACT DESCRIPTION

1.03 DESCRIPTION OF ALTERATIONS WORK

- A. Scope of demolition and removal work is indicated on drawings and specified in Section 02 41 00.

1.04 OWNER OCCUPANCY

- A. Owner intends to continue to occupy adjacent portions of the existing building during the entire construction period.
- B. Owner intends to occupy the Project upon Substantial Completion.
- C. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- D. Schedule the Work to accommodate Owner occupancy.

1.05 CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: Limited to areas noted on Drawings and owner-designated staging area.
 - 1. Locate and conduct construction activities in ways that will limit disturbance to site.
- B. Arrange use of site and premises to allow:
 - 1. Owner occupancy.
 - 2. Use of site and premises by the public.
- C. Provide access to and from site as required by law and by Owner:
 - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.
- D. Utility Outages and Shutdown:
 - 1. Limit disruption of utility services to hours the building is unoccupied where possible.
 - 2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 7 days notice to Owner and authorities having jurisdiction.
 - 3. Prevent accidental disruption of utility services to other facilities.

1.06 WORK SEQUENCE

- A. Coordinate construction schedule and operations with Owner.

1.07 SPECIFICATION SECTIONS APPLICABLE TO EVERY CONTRACT

- A. Unless otherwise noted, provisions of the sections listed below apply to every contract.
Specific items of work listed under individual contract descriptions constitute exceptions.
- B. Section 00 01 03 - DESIGN TEAM.
- C. Section 01 23 00 - Alternates.
- D. Section 01 25 00 - Substitution Procedures.
- E. Section 01 30 00 - Administrative Requirements.
- F. Section 01 32 16 - Construction Progress Schedule.
- G. Section 01 35 53 - Security Procedures.
- H. Section 01 40 00 - Quality Requirements.
- I. Section 01 42 16 - Definitions.
- J. Section 01 42 19 - Reference Standards.
- K. Section 01 55 00 - Vehicular Access and Parking.
- L. Section 01 60 00 - Product Requirements.
- M. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- N. Section 01 70 00 - Execution and Closeout Requirements.
- O. Section 01 78 00 - Closeout Submittals.

END OF SECTION 01 10 00

**SECTION 01 23 00
ALTERNATES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Description of Alternates.

1.02 SCHEDULE OF ALTERNATES

- A. Alternate No. 1 - Alteration and construction work as required to provide an infusion reception/check-in desk in the shared lobby space outside the oncology infusion clinical space. Included as part of this work will be the removal of a section of concrete slab, routing new below floor electrical and technology conduit to the reception/check-in desk, infilling the trench with new reinforced concrete, and installation of new finished flooring:

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 23 00

**SECTION 01 25 00
SUBSTITUTION PROCEDURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedural requirements for proposed substitutions.

1.02 RELATED REQUIREMENTS

- A. Section 01 23 00 - Alternates, for product alternatives affecting this section.
- B. Section 01 30 00 - Administrative Requirements: Submittal procedures, coordination.
- C. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions: Restrictions on emissions of indoor substitute products.

1.03 DEFINITIONS

- A. Substitutions: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.
 - 1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control.
 - a. Unavailability.
 - b. Regulatory changes.
 - 2. Substitutions for Convenience: Proposed due to possibility of offering substantial advantage to the Project.
 - a. Substitution requests offering advantages solely to the Contractor will not be considered.

1.04 REFERENCE STANDARDS

- A. CSI/CSC Form 1.5C - Substitution Request (During the Bidding/Negotiating Stage); Current Edition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
 - 2. Agrees to provide the same warranty for the substitution as for the specified product.
 - 3. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension that may subsequently become apparent.
- B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
 - 1. Note explicitly any non-compliant characteristics.
- C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
 - 1. No specific form is required. Contractor's Substitution Request documentation must include the following:
 - a. Project Information:
 - 1) Official project name and number, and any additional required identifiers established in Contract Documents.

- 2) Owner's, Architect's, and Contractor's names.
- b. Substitution Request Information:
 - 1) Discrete and consecutive Substitution Request number, and descriptive subject/title.
 - 2) Issue date.
 - 3) Reference to particular Contract Document(s) specification section number, title, and article/paragraph(s).
 - 4) Description of Substitution.
 - 5) Reason why the specified item cannot be provided.
 - 6) Differences between proposed substitution and specified item.
 - 7) Description of how proposed substitution affects other parts of work.
- c. Attached Comparative Data: Provide point-by-point, side-by-side comparison addressing essential attributes specified, as appropriate and relevant for the item:
 - 1) Physical characteristics.
 - 2) In-service performance.
 - 3) Expected durability.
 - 4) Visual effect.
 - 5) Warranties.
 - 6) Other salient features and requirements.
 - 7) Include, as appropriate or requested, the following types of documentation:
 - (a) Product Data:
 - (b) Samples.
 - (c) Certificates, test, reports or similar qualification data.
 - (d) Drawings, when required to show impact on adjacent construction elements.
- d. Impact of Substitution:
 - 1) Savings to Owner for accepting substitution.
 - 2) Change to Contract Time due to accepting substitution.
- D. Limit each request to a single proposed substitution item.
 - 1. Submit an electronic document, combining the request form with supporting data into single document.

3.02 SUBSTITUTION PROCEDURES DURING PROCUREMENT

- A. Submittal Time Restrictions:
 - 1. Owner will consider requests for substitutions only if submitted at least 10 days prior to the date for receipt of bids.

3.03 RESOLUTION

- A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.
- B. Architect will notify Contractor in writing of decision to accept or reject request.
 - 1. Architect's decision following review of proposed substitution will be noted on the submitted form.

3.04 ACCEPTANCE

- A. Accepted substitutions change the work of the Project. They will be documented and incorporated into work of the project by Change Order, Construction Change Directive, Architectural Supplementary Instructions, or similar instruments provided for in the Conditions of the Contract.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

END OF SECTION 01 25 00

**SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General administrative requirements.
- B. Electronic document submittal service.
- C. Preconstruction meeting.
- D. Site mobilization meeting.
- E. Progress meetings.
- F. Progress photographs.
- G. Submittals for review, information, and project closeout.
- H. Number of copies of submittals.
- I. Requests for Interpretation (RFI) procedures.
- J. Submittal procedures.

1.02 RELATED REQUIREMENTS

- A. Section 01 32 16 - Construction Progress Schedule: Form, content, and administration of schedules.
- B. Section 01 60 00 - Product Requirements: General product requirements.
- C. Section 01 70 00 - Execution and Closeout Requirements: Additional coordination requirements.
- D. Section 01 78 00 - Closeout Submittals: Project record documents; operation and maintenance data; warranties and bonds.
- E. Section 01 91 13 - General Commissioning Requirements: Additional procedures for submittals relating to commissioning.
 - 1. Where submittals are indicated for review by both Architect and the Commissioning Authority, submit one extra and route to Architect first, for forwarding to the Commissioning Authority.
 - 2. Where submittals are not indicated to be reviewed by Architect, submit directly to the Commissioning Authority; otherwise, the procedures specified in this section apply to commissioning submittals.

1.03 GENERAL ADMINISTRATIVE REQUIREMENTS

- A. Comply with requirements of Section 01 70 00 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.
- B. Make the following types of submittals to Architect:
 - 1. Requests for Interpretation (RFI).
 - 2. Requests for substitution.
 - 3. Shop drawings, product data, and samples.
 - 4. Test and inspection reports.
 - 5. Design data.
 - 6. Manufacturer's instructions and field reports.
 - 7. Applications for payment and change order requests.
 - 8. Progress schedules.
 - 9. Coordination drawings.
 - 10. Correction Punch List and Final Correction Punch List for Substantial Completion.

11. Closeout submittals.

1.04 PROJECT COORDINATOR

- A. Project Coordinator: Construction Manager.
- B. Cooperate with the Project Coordinator in allocation of mobilization areas of site; for field offices and sheds, for access, traffic, and parking facilities.
- C. During construction, coordinate use of site and facilities through the Project Coordinator.
- D. Comply with Project Coordinator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
- E. Make the following types of submittals to Architect through the Project Coordinator:
 - 1. Requests for Interpretation.
 - 2. Shop drawings, product data, and samples.
 - 3. Test and inspection reports.
 - 4. Design data.
 - 5. Manufacturer's instructions and field reports.
 - 6. Applications for payment and change order requests.
 - 7. Progress schedules.
 - 8. Coordination drawings.
 - 9. Correction Punch List and Final Correction Punch List for Substantial Completion.
 - 10. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRONIC DOCUMENT SUBMITTAL SERVICE

- A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF, MS Word, or MS Excel) format, as appropriate to the document, and transmitted via an Internet-based submittal service that receives, logs and stores documents, provides electronic stamping and signatures, and notifies addressees via email.
 - 1. Besides submittals for review, information, and closeout, this procedure applies to Requests for Interpretation (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
 - 2. Contractor and Architect are required to use this service.
 - 3. It is Contractor's responsibility to submit documents in allowable format.
 - 4. Subcontractors, suppliers, and Architect's consultants will be permitted to use the service at no extra charge.
 - 5. Users of the service need an email address, internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, www.adobe.com, or Bluebeam PDF Revu, www.bluebeam.com), unless such software capability is provided by the service provider.
 - 6. Paper document transmittals will not be reviewed; emailed electronic documents will not be reviewed.
 - 7. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.
- B. Training: If Owner and Architect are unfamiliar with the service provided, one, one-hour, web-based training session will be arranged for all participants, with representatives of Architect and Contractor participating; further training is the responsibility of the user of the service.

1. Representatives of Owner are scheduled and included in this training.
- C. Project Closeout: Architect will determine when to terminate the service for the project and is responsible for obtaining archive copies of files for Owner.

3.02 PRECONSTRUCTION MEETING

- A. Project Coordinator will schedule a meeting after Notice of Award.
- B. Attendance Required:
 1. Owner.
 2. Architect.
 3. Contractor.
- C. Agenda:
 1. Execution of Owner-Contractor Agreement.
 2. Submission of executed bonds and insurance certificates.
 3. Distribution of Contract Documents.
 4. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
 5. Designation of personnel representing the parties to Contract and Architect.
 6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 7. Scheduling.
- D. Record minutes and distribute copies within two days after meeting to participants, with copies to Architect, Owner, participants, and those affected by decisions made.

3.03 SITE MOBILIZATION MEETING

- A. Project Coordinator will schedule meeting at the Project site prior to Contractor occupancy.
- B. Attendance Required:
 1. Contractor.
 2. Owner.
 3. Contractor's superintendent.
 4. Major subcontractors.
- C. Agenda:
 1. Use of premises by Owner and Contractor.
 2. Owner's requirements.
 3. Security and housekeeping procedures.
 4. Schedules.
 5. Application for payment procedures.
 6. Procedures for testing.
 7. Procedures for maintaining record documents.
 8. Requirements for start-up of equipment.
 9. Inspection and acceptance of equipment put into service during construction period.
- D. Record minutes and distribute copies within two days after meeting to participants, with copies to Architect, Owner, participants, and those affected by decisions made.

3.04 PROGRESS MEETINGS

- A. Project Coordinator will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- B. Attendance Required:
 1. Contractor.
 2. Owner.

3. Architect.
 4. Contractor's superintendent.
 5. Major subcontractors.
- C. Agenda:
1. Review minutes of previous meetings.
 2. Review of work progress.
 3. Field observations, problems, and decisions.
 4. Identification of problems that impede, or will impede, planned progress.
 5. Review of submittals schedule and status of submittals.
 6. Maintenance of progress schedule.
 7. Corrective measures to regain projected schedules.
 8. Planned progress during succeeding work period.
 9. Maintenance of quality and work standards.
 10. Effect of proposed changes on progress schedule and coordination.
 11. Other business relating to work.
- D. Record minutes and distribute copies within two days after meeting to participants, with copies to Architect, Owner, participants, and those affected by decisions made.

3.05 CONSTRUCTION PROGRESS SCHEDULE

3.06 PROGRESS PHOTOGRAPHS

- A. Submit new photographs at least once a month, within 3 days after being taken.
- B. Photography Type: Digital; electronic files.
- C. Provide photographs of construction throughout progress of work produced by an experienced photographer, acceptable to Architect.
- D. Digital Photographs: 24 bit color, minimum resolution of 1024 by 768, in JPG format; provide files unaltered by photo editing software.
 1. Delivery Medium: Electronic document submittal service.
 2. File Naming: Include project identification, date and time of view, and view identification.

3.07 REQUESTS FOR INTERPRETATION (RFI)

- A. Definition: A request seeking one of the following:
 1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
 2. A resolution to an issue which has arisen due to field conditions and affects design intent.
- B. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.
- C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
 1. Prepare a separate RFI for each specific item.
 - a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
 - b. Do not forward requests which solely require internal coordination between subcontractors.
 2. Prepare in a format and with content acceptable to Owner.
 3. Prepare using software provided by the Electronic Document Submittal Service.

- D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
 - 1. Unacceptable Uses for RFIs: Do not use RFIs to request the following:
 - a. Approval of submittals (use procedures specified elsewhere in this section).
 - b. Approval of substitutions (see Section - 01 60 00 - Product Requirements)
 - 2. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
 - 3. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.
- E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
 - 1. Official Project name and number, and any additional required identifiers established in Contract Documents.
 - 2. Owner's, Architect's, and Contractor's names.
 - 3. Discrete and consecutive RFI number, and descriptive subject/title.
 - 4. Issue date, and requested reply date.
 - 5. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
 - 6. Annotations: Field dimensions and/or description of conditions which have engendered the request.
 - 7. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.
- F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
- G. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
 - 1. Indicate current status of every RFI. Update log promptly and on a regular basis.
 - 2. Note dates of when each request is made, and when a response is received.
 - 3. Highlight items requiring priority or expedited response.
 - 4. Highlight items for which a timely response has not been received to date.
- H. Review Time: Architect will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.
 - 1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.
- I. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
 - 1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
 - 2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.

3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
4. Notify Architect within seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.08 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
 1. Product data.
 2. Shop drawings.
 3. Samples for selection.
 4. Samples for verification.
- B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
- C. Samples will be reviewed for aesthetic, color, or finish selection.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 78 00 - Closeout Submittals.

3.09 SUBMITTALS FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
 1. Design data.
 2. Certificates.
 3. Test reports.
 4. Inspection reports.
 5. Manufacturer's instructions.
 6. Manufacturer's field reports.
 7. Other types indicated.
- B. Submit for Architect's knowledge as contract administrator or for Owner.

3.10 SUBMITTALS FOR PROJECT CLOSEOUT

- A. Submit Correction Punch List for Substantial Completion.
- B. Submit Final Correction Punch List for Substantial Completion.
- C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 78 00 - Closeout Submittals:
 1. Project record documents.
 2. Operation and maintenance data.
 3. Warranties.
 4. Bonds.
 5. Other types as indicated.
- D. Submit for Owner's benefit during and after project completion.

3.11 NUMBER OF COPIES OF SUBMITTALS

- A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
- B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
 1. After review, produce duplicates.
 2. Retained samples will not be returned to Contractor unless specifically so stated.

3.12 SUBMITTAL PROCEDURES

A. General Requirements:

1. Use a separate transmittal for each item.
2. Use a single transmittal for related items.
3. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
4. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
5. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
 - a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
6. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
 - a. Upload submittals in electronic form to Electronic Document Submittal Service website.
7. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - a. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
 - b. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 days.
 - c. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Architect's approval, allow an additional 30 days.
8. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
9. Provide space for Contractor and Architect review stamps.
10. When revised for resubmission, identify all changes made since previous submission.
11. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
12. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
13. Submittals not requested will be recognized, and will be returned "Not Reviewed",

B. Product Data Procedures:

1. Submit only information required by individual specification sections.
2. Collect required information into a single submittal.
3. Do not submit (Material) Safety Data Sheets for materials or products.

C. Shop Drawing Procedures:

1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
2. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

D. Samples Procedures:

1. Transmit related items together as single package.
2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.13 SUBMITTAL REVIEW

- A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.
- B. Submittals for Information: Architect will acknowledge receipt and review. See below for actions to be taken.
- C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
- D. Architect's and consultants' actions on items submitted for review:
 - 1. Authorizing purchasing, fabrication, delivery, and installation:
 - a. "Reviewed", or language with same legal meaning.
 - b. "Reviewed as Noted", or language with same legal meaning.
 - 1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
 - 2. Not Authorizing fabrication, delivery, and installation:
 - a. "Revise and Resubmit".
 - 1) Resubmit revised item, with review notations acknowledged and incorporated.
 - 2) Non-responsive resubmittals may be rejected.
 - b. "Rejected".
 - 1) Submit item complying with requirements of Contract Documents.
- E. Architect's and consultants' actions on items submitted for information:
 - 1. Items for which no action was taken:
 - a. "Received" - to notify the Contractor that the submittal has been received for record only.
 - 2. Items for which action was taken:
 - a. "Reviewed" - no further action is required from Contractor.

END OF SECTION 01 30 00

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preliminary schedule.
- B. Construction progress schedule, bar chart type.

1.02 REFERENCE STANDARDS

- A. AGC (CPSM) - Construction Planning and Scheduling Manual; 2004.
- B. M-H (CPM) - CPM in Construction Management - Project Management with CPM; 2016.

1.03 SUBMITTALS

- A. Within 10 days after date of Agreement, submit preliminary schedule.
- B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
- D. Within 10 days after joint review, submit complete schedule.
- E. Submit in PDF format.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE

- A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 CONTENT

- A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- B. Identify each item by specification section number.
- C. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
- D. Indicate delivery dates for owner-furnished products.
- E. Provide legend for symbols and abbreviations used.

3.03 BAR CHARTS

- A. Include a separate bar for each major portion of Work or operation.
- B. Identify the first work day of each week.

3.04 REVIEW AND EVALUATION OF SCHEDULE

- A. Participate in joint review and evaluation of schedule with Architect at each submittal.
- B. Evaluate project status to determine work behind schedule and work ahead of schedule.
- C. After review, revise as necessary as result of review, and resubmit within 10 days.

3.05 UPDATING SCHEDULE

- A. Maintain schedules to record actual start and finish dates of completed activities.
- B. Indicate progress of each activity to date of revision, with projected completion date of each activity.
- C. Annotate diagrams to graphically depict current status of Work.

- D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
- E. Indicate changes required to maintain Date of Substantial Completion.
- F. Submit reports required to support recommended changes.

3.06 DISTRIBUTION OF SCHEDULE

- A. Distribute copies of updated schedules to Contractor's project site file, to subcontractors, suppliers, Architect, Owner, and other concerned parties.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

END OF SECTION 01 32 16

**SECTION 01 35 53
SECURITY PROCEDURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Security measures including personnel identification and miscellaneous restrictions.

1.02 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: use of premises and occupancy.
- B. Section 01 50 00 - Temporary Facilities and Controls: Temporary lighting.

1.03 PERSONNEL IDENTIFICATION

- A. Provide identification badge to each person authorized to enter premises.
- B. Badge To Include: Personal photograph, name, assigned number , expiration date and employer.
- C. Maintain a list of accredited persons, submit copy to Owner on request.
- D. Require return of badges at expiration of their employment on the Work.

1.04 RESTRICTIONS

- A. Do not allow cameras on site or photographs taken except by written approval of Owner.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 35 53

**SECTION 01 40 00
QUALITY REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submittals.
- B. Quality assurance.
- C. References and standards.
- D. Testing and inspection agencies and services.
- E. Contractor's design-related professional design services.
- F. Control of installation.
- G. Mock-ups.
- H. Tolerances.
- I. Manufacturers' field services.
- J. Defect Assessment.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittal procedures.
- B. Section 01 42 16 - Definitions.
- C. Section 01 60 00 - Product Requirements: Requirements for material and product quality.

1.03 REFERENCE STANDARDS

- A. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2023.
- B. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing; 2021.
- C. ASTM E699 - Standard Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components; 2016.
- D. IAS AC89 - Accreditation Criteria for Testing Laboratories; 2021.

1.04 DEFINITIONS

- A. Contractor's Professional Design Services: Design of some aspect or portion of the project by party other than the design professional of record. Provide these services as part of the Contract for Construction.
 - 1. Design Services Types Required:
 - a. Construction-Related: Services Contractor needs to provide in order to carry out the Contractor's sole responsibilities for construction means, methods, techniques, sequences, and procedures.
 - b. Design-Related: Design services explicitly required to be performed by another design professional due to highly-technical and/or specialized nature of a portion of the project. Services primarily involve engineering analysis, calculations, and design, and are not intended to alter the aesthetic aspects of the design.
- B. Design Data: Design-related, signed and sealed drawings, calculations, specifications, certifications, shop drawings and other submittals provided by Contractor, and prepared directly by, or under direct supervision of, appropriately licensed design professional.

1.05 CONTRACTOR'S DESIGN-RELATED PROFESSIONAL DESIGN SERVICES

- A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.

- B. Base design on performance and/or design criteria indicated in individual specification sections.
 - 1. Submit a Request for Interpretation to Architect if the criteria indicated are not sufficient to perform required design services.
- C. Scope of Contractor's Professional Design Services: Provide for the following items of work:
 - 1. Sprinkler Layout: Coordinate with ceiling installation, detailed pipe layout, and hydraulic calculations as described in Section 21 13 00 - Fire-Suppression Sprinkler Systems.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.
- C. Test Reports: After each test/inspection, promptly submit copies of report to Architect and to Contractor.
 - 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and specifications section.
 - f. Location in the Project.
 - g. Type of test/inspection.
 - h. Date of test/inspection.
 - i. Results of test/inspection.
 - j. Compliance with Contract Documents.
 - k. When requested by Architect, provide interpretation of results.
- D. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in quantities specified for Product Data.
 - 1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 - 2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect.
- E. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
- F. Manufacturer's Field Reports: Submit reports for Architect's benefit as contract administrator or for Owner.
 - 1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.

1.07 QUALITY ASSURANCE

- A. Testing Agency Qualifications:
 - 1. Prior to start of work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
- B. Designer Qualifications: Where professional engineering design services and design data submittals are specifically required of Contractor by Contract Documents, provide services of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

- C. Contractor's Quality Control (CQC) Plan:
1. Prior to start of work, submit a comprehensive plan describing how contract deliverables will be produced. Tailor CQC plan to specific requirements of the project. Include the following information:
 - a. Management Structure: Identify personnel responsible for quality. Include a chart showing lines of authority.
 - b. Management Approach: Define, describe, and include in the plan specific methodologies used in executing the work.
 - c. Acceptance of the plan is required prior to start of construction activities not including mobilization work. Owner's acceptance of the plan will be conditional and predicated on continuing satisfactory adherence to the plan. Owner reserves the right to require Contractor to make changes to the plan and operations, including removal of personnel, as necessary, to obtain specified quality of work results.
- D. Quality-Control Personnel Qualifications. Engage a person with requisite training and experience to implement and manage quality assurance (QA) and quality control (QC) for the project.

1.08 REFERENCES AND STANDARDS

- A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.
- C. Obtain copies of standards where required by product specification sections.
- D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.
- E. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.
- F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from Contract Documents by mention or inference otherwise in any reference document.

1.09 TESTING AND INSPECTION AGENCIES AND SERVICES

- A. As indicated in individual specification sections, Owner or Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.
- B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

1.10 INFECTION CONTROL MEASURES

- A. The owner will prepare an infection control risk assessment at each major work area and will impose requirements on the project to control the spread of dust and airborne pathogens disturbed during construction operations and to prevent migration of such into sensitive areas of the facility. The contractor shall be prepared to address these requirements, which may include the following elements.
 1. Provide sticky tack mats at entrances and exits from construction areas, as required.
 2. Provide units capable of supplying negative pressure in active construction areas. If units recirculate air within this space, the units will be capable of filtering the air utilizing hepa filtration.
 3. Contractor will be required to cover any construction debris and wipe down carts before traveling through any patient care area.

4. Contractor will be required to seal all holes, pipes and conduit and other wall penetrations, as required, at barriers between construction operations and adjacent patient care areas.
5. If construction areas are in proximity to high risk patient populations, contractor may be required to build ante room for personnel to pass through, so the personnel can be vacuumed using a hepa vacuum prior to leaving the work site.
6. Construction personnel may be required to wear sterile personal protective equipment when working in high risk patient care areas.
7. Contractor shall familiarize himself with the infection control risk assessment matrix attached as an appendix to this project manual for all measures that may be required in this project.
8. When project is to be completed in phases, or as otherwise noted, provide temporary partitions and / or ceilings as required to separate work areas from owner occupied areas, to prevent penetration of dust and moisture into owner occupied areas, and to prevent damage to existing materials and equipment.
 - a. in occupied areas, in areas where extensive remodel work is being performed over an extended period of time, temporary partitions shall, at a minimum, consist of 5/8" type-x gypsum board each side over steel studs or fire retardant wood studs at 24" o.c.. these areas need not be taped unless in a rated egress area. walls shall provide a one-hour barrier and doors, if required shall be 60 minute rated.
 - b. where subject to human impact loads, including but not limited to enclosures around elevator and other shafts and temporary partitions in corridors, 3/4" fire retardant plywood shall be used in lieu of 5/8" type-x gypsum board specified above.
 - c. dust proof partitions may be constructed of fire retardant plastic over steel studs.
 - d. dust partitions shall extend from floor to deck above.
 - e. consult with architect for exact placement of dust proof partitions prior to installation.
 - f. dust proof partitions shall be maintained in good repair throughout the construction period, and shall be installed and removed in a manner which will not damage the permanent building finishes. repair of any finishes damaged by installation or removal of dust partitions shall be made at no additional cost to owner.
9. refer to mechanical and electrical specifications for information regarding sealing and cleaning of ductwork and other operational measures that may be required.
10. **Prepare a Infection Control protocol with input by Owner, Include Covid 19 Measures.**

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Have work performed by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 MOCK-UPS

- A. Before installing portions of the Work where mock-ups are required, construct mock-ups in location and size indicated for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work. The purpose of mock-up is to demonstrate the proposed range of aesthetic effects and workmanship.
- B. Accepted mock-ups establish the standard of quality the Architect will use to judge the Work.
- C. Notify Architect fifteen (15) working days in advance of dates and times when mock-ups will be constructed.
- D. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- E. Obtain Architect's approval of mock-ups before starting work, fabrication, or construction.
- F. Architect will use accepted mock-ups as a comparison standard for the remaining Work.
- G. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, protect mock-up throughout construction, remove mock-up and clear area when directed to do so by Architect.

3.03 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

3.04 TESTING AND INSPECTION

- A. See individual specification sections for testing and inspection required.
- B. Testing Agency Duties:
 - 1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 - 2. Perform specified sampling and testing of products in accordance with specified standards.
 - 3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 4. Promptly notify Architect and Contractor of observed irregularities or non-compliance of Work or products.
 - 5. Perform additional tests and inspections required by Architect.
 - 6. Submit reports of all tests/inspections specified.
- C. Limits on Testing/Inspection Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the Work.
 - 3. Agency may not assume any duties of Contractor.
 - 4. Agency has no authority to stop the Work.
- D. Contractor Responsibilities:
 - 1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
 - 2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
 - 3. Provide incidental labor and facilities:
 - a. To provide access to Work to be tested/inspected.

- b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
- c. To facilitate tests/inspections.
- d. To provide storage and curing of test samples.
- 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
- 5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- 6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- E. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.
- F. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.05 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment as applicable, and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.06 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not complying with specified requirements.

END OF SECTION 01 40 00

**SECTION 01 41 00
REGULATORY REQUIREMENTS**

PART 1 GENERAL

1.01 SUMMARY OF REFERENCE STANDARDS

- A. Regulatory requirements applicable to this project are the following:
- B. Arkansas Fire Prevention Code (AFPC), Volume I (Fire Code), Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. Arkansas Fire Prevention Code (AFPC), Volume II (Building Code), Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements
- D. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- E. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- F. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.
- G. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- H. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. ICC (IPC) - International Plumbing Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. ICC (IMC) - International Mechanical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. ICC (IPMC) - International Property Maintenance Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.02 RELATED REQUIREMENTS

- A. Section 01 40 00 - Quality Requirements.

1.03 QUALITY ASSURANCE

- A. Contractor's Designer Qualifications: Refer to Section - 01 40 00 - Quality Requirements.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 41 00

SECTION 01 42 16
DEFINITIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Other definitions are included in individual specification sections.

1.02 DEFINITIONS

- A. Furnish: To supply, deliver, unload, and inspect for damage.
- B. Install: To unpack, assemble, erect, apply, place, finish, cure, protect, clean, start up, and make ready for use.
- C. Product: Material, machinery, components, equipment, fixtures, and systems forming the work result. Not materials or equipment used for preparation, fabrication, conveying, or erection and not incorporated into the work result. Products may be new, never before used, or re-used materials or equipment.
- D. Project Manual: The book-sized volume that includes the procurement requirements (if any), the contracting requirements, and the specifications.
- E. Provide: To furnish and install.
- F. Supply: Same as Furnish.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 42 16

SECTION 01 45 33
CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Code-required special inspections.
- B. Testing services incidental to special inspections.
- C. Submittals.
- D. Manufacturers' field services.
- E. Fabricators' field services.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittal procedures.
- B. Section 01 40 00 - Quality Requirements.
- C. Section 01 60 00 - Product Requirements: Requirements for material and product quality.

1.03 ABBREVIATIONS AND ACRONYMS

- A. AHJ: Authority having jurisdiction.
- B. IAS: International Accreditation Service, Inc.
- C. NIST: National Institute of Standards and Technology.

1.04 DEFINITIONS

- A. Code or Building Code: Arkansas Fire Prevention Code (AFPC), Volume II, Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements and specifically, Chapter 17 - Special Inspections and Tests.
- B. Authority Having Jurisdiction (AHJ): Agency or individual officially empowered to enforce the building, fire and life safety code requirements of the permitting jurisdiction in which the Project is located.
- C. Special Inspection:
 - 1. Special inspections are inspections and testing of materials, installation, fabrication, erection or placement of components and connections mandated by the AHJ that also require special expertise to ensure compliance with the approved Contract Documents and the referenced standards.
 - 2. Special inspections are separate from and independent of tests and inspections conducted by Owner or Contractor for the purposes of quality assurance and contract administration.

1.05 REFERENCE STANDARDS

- A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- B. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- C. ASTM A706/A706M - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement; 2022a.
- D. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field; 2024.
- E. ASTM C172/C172M - Standard Practice for Sampling Freshly Mixed Concrete; 2017.

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Code-Required Special
Inspections and Procedures

01 45 33 - 1

- F. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2023.
- G. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing; 2021.
- H. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems; 2020a.
- I. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers; 2020a.
- J. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- K. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel; 2018, with Errata (2022).
- L. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars; 2018, with Amendment (2020).
- M. IAS AC89 - Accreditation Criteria for Testing Laboratories; 2021.
- N. IAS AC291 - Accreditation Criteria for Special Inspection Agencies AC291; 2019.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Special Inspection Agency Qualifications: Prior to the start of work, the Special Inspection Agency is required to:
 - 1. Submit agency name, address, and telephone number, names of full time registered Engineer and responsible officer.
 - 2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
 - 3. Submit certification that Special Inspection Agency is acceptable to AHJ.
 - 4. Submit documentation that Special Inspection Agency is accredited by IAS according to IAS AC291.
- C. Testing Agency Qualifications: Prior to the start of work, the Testing Agency is required to:
 - 1. Submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
 - 2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
 - 3. Submit certification that Testing Agency is acceptable to AHJ.
 - 4. Submit documentation that Testing Agency is accredited by IAS according to IAS AC89.
- D. Manufacturer's Qualification Statement: Manufacturer is required to submit documentation of manufacturing capability and quality control procedures. Include documentation of AHJ approval.
- E. Fabricator's Qualification Statement: Fabricator is required to submit documentation of fabrication facilities and methods as well as quality control procedures. Include documentation of AHJ approval.
- F. Special Inspection Reports: After each special inspection, Special Inspector is required to promptly submit at least copies of report; one to Architect and one to the AHJ.
 - 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of Special Inspector.
 - d. Date and time of special inspection.
 - e. Identification of product and specifications section.

- f. Location in the Project.
 - g. Type of special inspection.
 - h. Date of special inspection.
 - i. Results of special inspection.
 - j. Compliance with Contract Documents.
 - 2. Final Special Inspection Report: Document special inspections and correction of discrepancies prior to the start of the work.
- G. Fabricator Special Inspection Reports: After each special inspection of fabricated items at the Fabricator's facility, Special Inspector is required to promptly submit at least copies of report; one to Architect and one to AHJ.
- 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of Special Inspector.
 - d. Date and time of special inspection.
 - e. Identification of fabricated item and specification section.
 - f. Location in the Project.
 - g. Results of special inspection.
 - h. Verification of fabrication and quality control procedures.
 - i. Compliance with Contract Documents.
 - j. Compliance with referenced standard(s).
- H. Test Reports: After each test or inspection, promptly submit at least copies of report; one to Architect and one to AHJ.
- 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and specifications section.
 - f. Location in the Project.
 - g. Type of test or inspection.
 - h. Date of test or inspection.
 - i. Results of test or inspection.
 - j. Compliance with Contract Documents.
- I. Certificates: When specified in individual special inspection requirements, Special Inspector shall submit certification by the manufacturer, fabricator, and installation subcontractor to Architect and AHJ, in quantities specified for Product Data.
- 1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 - 2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect and AHJ.
- J. Manufacturer's Field Reports: Submit reports to Architect and AHJ.
- 1. Submit report in duplicate within 30 days of observation to Architect for information.
 - 2. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in Contract Documents.
- K. Fabricator's Field Reports: Submit reports to Architect and AHJ.
- 1. Submit report within 30 days of observation to Architect for information.

2. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in Contract Documents.

1.07 SPECIAL INSPECTION AGENCY

- A. Owner or Architect will employ services of a Special Inspection Agency to perform inspections and associated testing and sampling in accordance with ASTM E329 and required by the building code.
- B. The Special Inspection Agency may employ and pay for services of an independent testing agency to perform testing and sampling associated with special inspections and required by the building code.
- C. Employment of agency in no way relieves Contractor of obligation to perform work in accordance with requirements of Contract Documents.

1.08 TESTING AND INSPECTION AGENCIES

- A. Owner or Architect may employ services of an independent testing agency to perform additional testing and sampling associated with special inspections but not required by the building code.
- B. Employment of agency in no way relieves Contractor of obligation to perform work in accordance with requirements of Contract Documents.

1.09 QUALITY ASSURANCE

- A. Special Inspection Agency Qualifications:
 1. Independent firm specializing in performing testing and inspections of the type specified in this section.
 2. Accredited by IAS according to IAS AC291.
- B. Testing Agency Qualifications:
 1. Independent firm specializing in performing testing and inspections of the type specified in this section.
 2. Accredited by IAS according to IAS AC89.
- C. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SCHEDULE OF SPECIAL INSPECTIONS, GENERAL

- A. Frequency of Special Inspections: Special Inspections are indicated as continuous or periodic.
 1. Continuous Special Inspection: Special Inspection Agency is required to be present in the area where the work is being performed and observe the work at all times the work is in progress.
 2. Periodic Special Inspection: Special Inspection Agency is required to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.

3.02 SPECIAL INSPECTIONS FOR STEEL CONSTRUCTION

- A. Structural Steel: Comply with quality assurance inspection requirements of ICC (IBC)-2018.
- B. High-Strength Bolt, Nut and Washer Material:
 1. Verify identification markings comply with ASTM standards specified in the approved contract and to AISC 360, Section A3.3; periodic.
 2. Submit manufacturer's certificates of compliance; periodic.

- C. High-Strength Bolting Installation: Verify items listed below comply with AISC 360, Section M2.5.
 - 1. Snug tight joints; periodic.
 - 2. Pretensioned and slip-critical joints with matchmarking, twist-off bolt or direct tension indicator method of installation; periodic.
 - 3. Pretensioned and slip-critical joints without matchmarking or calibrated wrench method of installation; continuous.
- D. Weld Filler Material:
 - 1. Verify identification markings comply with AWS standards specified in the approved Contract Documents and to AISC 360, Section A3.5; periodic.
 - 2. Submit manufacturer's certificates of compliance; periodic.
- E. Welding:
 - 1. Structural Steel and Cold Formed Steel Deck:
 - a. Complete and Partial Joint Penetration Groove Welds: Verify compliance with AWS D1.1/D1.1M; continuous.
 - b. Multipass Fillet Welds: Verify compliance with AWS D1.1/D1.1M; continuous.
 - c. Single Pass Fillet Welds Less than 5/16 inch Wide: Verify compliance with AWS D1.1/D1.1M; periodic.
 - d. Plug and Slot Welds: Verify compliance with AWS D1.1/D1.1M; continuous.
 - e. Single Pass Fillet Welds 5/16 inch or Greater: Verify compliance with AWS D1.1/D1.1M; continuous.
 - f. Floor and Roof Deck Welds: Verify compliance with AWS D1.3/D1.3M; continuous.
 - 2. Reinforcing Steel: Verify items listed below comply with AWS D1.4/D1.4M and ACI CODE-318, Section 3.5.2.
 - a. Verification of weldability; periodic.
 - b. Reinforcing steel resisting flexural and axial forces in intermediate and special moment frames as well as where it is referenced in older codes. Elements of special structural walls of concrete and shear reinforcement; continuous.
 - c. Shear reinforcement; continuous.
 - d. Other reinforcing steel; periodic.

3.03 SPECIAL INSPECTIONS FOR CONCRETE CONSTRUCTION

- A. Reinforcement, Including Prestressing Tendons, and Verification of Placement: Verify compliance with ACI CODE-318, Chapters 20, 25.2, 25.3, 26.6.1-26.6.3; periodic.
- B. Reinforcing Bar Welding: Verify compliance with AWS D1.4/D1.4M and ACI CODE-318, 26.6.4; periodic.
 - 1. Verify weldability of reinforcing bars other than those complying with ASTM A706/A706M; periodic.
 - 2. Inspect single-pass fillet welds, maximum 5/16 inch; periodic.
 - 3. Inspect all other welds; continuous.
- C. Reinforcing Steel Welding: Verify compliance with AWS D1.4/D1.4M and ACI CODE-318, Section 3.5.2; periodic.
- D. Design Mix: Verify plastic concrete complies with the design mix in approved Contract Documents and with ACI CODE-318, Chapter 19, 16.4.3, 26.4.4; periodic.
- E. Concrete Sampling Concurrent with Strength Test Sampling: Each time fresh concrete is sampled for strength tests, verify compliance with ASTM C172/C172M, ASTM C31/C31M, and ACI CODE-318, Chapter 26.5, 26.12, and record the following, continuous:
 - 1. Slump.
 - 2. Air content.

3. Temperature of concrete.
- F. Concrete Sampling Concurrent with Strength Test Sampling: Each time fresh concrete is sampled for strength tests, verify compliance with ASTM C172/C172M, ASTM C31/C31M, and ACI CODE-318, Sections 5.6 and 5.8 and record the following, continuous:
 1. Slump.
 2. Air content.
 3. Temperature of concrete.
- G. Specified Curing Temperature and Techniques: Verify compliance with ACI CODE-318, Chapter 26.5.3 through 26.5.5; periodic.
- H. Welding of Reinforcing Bars: Conduct special inspections and verify Special Inspector's qualifications in accordance with requirements of AWS D1.4/D1.4M.

3.04 SPECIAL INSPECTIONS FOR FIRE RESISTANT PENETRATIONS AND JOINTS

- A. Verify penetration firestops in accordance with ASTM E2174.
- B. Verify fire resistant joints in accordance with ASTM E2393.

3.05 SPECIAL INSPECTION AGENCY DUTIES AND RESPONSIBILITIES

- A. Special Inspection Agency shall:
 1. Verify samples submitted by Contractor comply with the referenced standards and the approved Contract Documents.
 2. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 3. Perform specified sampling and testing of products in accordance with specified reference standards.
 4. Ascertain compliance of materials and products with requirements of Contract Documents.
 5. Promptly notify Architect and Contractor of observed irregularities or non-compliance of work or products.
 6. Perform additional tests and inspections required by Architect.
 7. Attend preconstruction meetings and progress meetings.
 8. Submit reports of all tests or inspections specified.
- B. Limits on Special Inspection Agency Authority:
 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Agency may not approve or accept any portion of the work.
 3. Agency may not assume any duties of Contractor.
 4. Agency has no authority to stop the work.
- C. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.
- D. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.06 TESTING AGENCY DUTIES AND RESPONSIBILITIES

- A. Testing Agency Duties:
 1. Test samples submitted by Contractor.
 2. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 3. Perform specified sampling and testing of products in accordance with specified standards.
 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.

5. Promptly notify Architect and Contractor of observed irregularities or non-compliance of work or products.
 6. Perform additional tests and inspections required by Architect.
 7. Attend preconstruction meetings and progress meetings.
 8. Submit reports of all tests or inspections specified.
- B. Limits on Testing or Inspection Agency Authority:
1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Agency may not approve or accept any portion of the work.
 3. Agency may not assume any duties of Contractor.
 4. Agency has no authority to stop the work.
- C. On instructions by Architect, perform re-testing required because of non-compliance with specified requirements, using the same agency.
- D. Contractor will pay for re-testing required because of non-compliance with specified requirements.

3.07 CONTRACTOR DUTIES AND RESPONSIBILITIES

- A. Contractor Responsibilities, General:
1. Deliver to agency at designated location, adequate samples of materials for special inspections that require material verification.
 2. Cooperate with agency and laboratory personnel; provide access to approved documents at project site and to the work.
 3. Provide incidental labor and facilities:
 - a. To provide access to work to be tested or inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested or inspected.
 - c. To facilitate tests or inspections.
 - d. To provide storage and curing of test samples.
 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing or inspection services.
 5. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
 6. Retain special inspection records.

3.08 MANUFACTURERS' AND FABRICATORS' FIELD SERVICES

- A. When specified in individual specification sections, require material suppliers, assembly fabricators, or product manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, to test, adjust, and balance equipment, and to initiate instructions when necessary.
- B. Submit qualifications of observer to Architect 30 days in advance of required observations.
1. Observer subject to approval of Architect.
 2. Observer subject to approval of Owner.
- C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

END OF SECTION 01 45 33

**SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary sanitary facilities.
- B. Temporary Controls: Barriers, enclosures, and fencing.
- C. Waste removal facilities and services.
- D. Project identification sign.

1.02 RELATED REQUIREMENTS

- A. Section 01 35 53 - Security Procedures
- B. Section 01 55 00 - Vehicular Access and Parking.
- C. Section 01 58 13 - Temporary Project Signage.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- B. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.

1.04 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
- B. Maintain daily in clean and sanitary condition.

1.05 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.06 FENCING

- A. Provide 6 foot high fence around staging area; equip with vehicular and pedestrian gates with locks.

1.07 INTERIOR ENCLOSURES

- A. Provide temporary partitions and ceilings as indicated to separate work areas from Owner-occupied areas, to prevent penetration of dust and moisture into Owner-occupied areas, and to prevent damage to existing materials and equipment.
- B. Construction: Framing and reinforced polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces:

1.08 SECURITY - SEE SECTION 01 35 53

1.09 VEHICULAR ACCESS AND PARKING - SEE SECTION 01 55 00

1.10 WASTE REMOVAL

- A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
- B. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.

- C. Provide containers with lids. Remove trash from site periodically.
- D. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.

1.11 PROJECT IDENTIFICATION

- A. Provide project identification sign of design and construction indicated on drawings.
- B. Erect on site at location indicated.
- C. No other signs are allowed without Owner permission except those required by law.

1.12 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 50 00

**SECTION 01 55 00
VEHICULAR ACCESS AND PARKING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Parking.
- B. Existing pavements and parking areas.
- C. Construction parking controls.
- D. Haul routes.
- E. Maintenance.
- F. Removal, repair.

1.02 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: For access to site, work sequence, and occupancy.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PARKING

- A. Use of designated areas of existing parking facilities by construction personnel is permitted.
- B. When site space is not adequate, provide additional off-site parking.

3.02 CONSTRUCTION PARKING CONTROL

- A. Control vehicular parking to prevent interference with public traffic and parking, access by emergency vehicles, and Owner's operations.
- B. Monitor parking of construction personnel's vehicles in existing facilities. Maintain vehicular access to and through parking areas.
- C. Prevent parking on or adjacent to access roads or in non-designated areas.

3.03 HAUL ROUTES

- A. Confine construction traffic to designated haul routes.
- B. Provide traffic control at critical areas of haul routes to regulate traffic, to minimize interference with public traffic.

3.04 MAINTENANCE

- A. Maintain traffic and parking areas in a sound condition.
- B. Maintain existing paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

3.05 REMOVAL, REPAIR

- A. Repair existing facilities damaged by use, to original condition.

END OF SECTION 01 55 00

**SECTION 01 58 13
TEMPORARY PROJECT SIGNAGE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project identification sign.
- B. Project informational signs.

1.02 QUALITY ASSURANCE

- A. Design sign and structure to withstand 50 miles/hr wind velocity.
- B. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.

PART 2 PRODUCTS

2.01 SIGN MATERIALS

- A. Structure and Framing: New, wood, structurally adequate.
- B. Sign Surfaces: Exterior grade plywood with medium density overlay, minimum 3/4 inch thick, standard large sizes to minimize joints.
- C. Rough Hardware: Galvanized.
- D. Paint and Primers: Exterior quality, two coats; sign background of color as selected.
- E. Lettering: Pre-cut vinyl self-adhesive products.

2.02 PROJECT IDENTIFICATION SIGN

- A. One painted sign, 32 sq ft area, bottom 6 feet above ground.
- B. Content:
 - 1. Project title, logo and name of Owner as indicated on Contract Documents.
 - 2. Names and titles of Architect and Consultants.
 - 3. Name of Prime Contractor and major Subcontractors.
- C. Graphic Design, Colors, Style of Lettering: Designated by Architect.

2.03 PROJECT INFORMATIONAL SIGNS

- A. Painted informational signs of same colors and lettering as Project Identification sign, or standard products; size lettering to provide legibility at 100 foot distance.
- B. Provide at each field office, storage shed, and directional signs to direct traffic into and within site. Relocate as Work progress requires.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install project identification sign within 30 days after date fixed by Notice to Proceed.
- B. Erect at designated location.
- C. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
- D. Install sign surface plumb and level, with butt joints. Anchor securely.
- E. Paint exposed surfaces of sign, supports, and framing.

3.02 MAINTENANCE

- A. Maintain signs and supports clean, repair deterioration and damage.

3.03 REMOVAL

- A. Remove signs, framing, supports, and foundations at completion of Project and restore the area.

END OF SECTION 01 58 13

**SECTION 01 60 00
PRODUCT REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General product requirements.
- B. Re-use of existing products.
- C. Transportation, handling, storage and protection.
- D. Product option requirements.
- E. Substitution limitations.
- F. Procedures for Owner-supplied products.
- G. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

- A. Section 01 25 00 - Substitution Procedures: Substitutions made during procurement and/or construction phases.
- B. Section 01 40 00 - Quality Requirements: Product quality monitoring.
- C. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.

1.03 REFERENCE STANDARDS

- A. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
 - 1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS

- A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by Contract Documents.
- B. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor; remove from site.

2.02 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by Contract Documents.

- B. See Section 01 40 00 - Quality Requirements, for additional source quality control requirements.
- C. Use of products having any of the following characteristics is not permitted:
 - 1. Made using or containing CFC's or HCFC's.
 - 2. Containing lead, cadmium, or asbestos.
- D. Where other criteria are met, Contractor shall give preference to products that:
 - 1. If used on interior, have lower emissions, as defined in Section 01 61 16.
 - 2. If wet-applied, have lower VOC content, as defined in Section 01 61 16.

2.03 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.04 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

- A. See Section 01 25 00 - Substitution Procedures.

3.02 OWNER-SUPPLIED PRODUCTS

- A. Owner's Responsibilities:
 - 1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
 - 2. Arrange and pay for product delivery to site.
 - 3. On delivery, inspect products jointly with Contractor.
 - 4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
 - 5. Arrange for manufacturers' warranties, inspections, and service.
- B. Contractor's Responsibilities:
 - 1. Review Owner reviewed shop drawings, product data, and samples.
 - 2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
 - 3. Handle, store, install and finish products.
 - 4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

- A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
- B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.
- C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- D. Transport and handle products in accordance with manufacturer's instructions.

- E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
- H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

- A. Provide protection of stored materials and products against theft, casualty, or deterioration.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.
- D. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Provide off-site storage and protection when site does not permit on-site storage or protection.
- G. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- H. Comply with manufacturer's warranty conditions, if any.
- I. Do not store products directly on the ground.
- J. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- K. Prevent contact with material that may cause corrosion, discoloration, or staining.
- L. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- M. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 01 60 00

SECTION 01 61 16
VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Requirements for Indoor-Emissions-Restricted products.
- B. Requirements for VOC-Content-Restricted products.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittal procedures.
- B. Section 01 40 00 - Quality Requirements: Procedures for testing and certifications.
- C. Section 01 60 00 - Product Requirements: Fundamental product requirements, substitutions and product options, delivery, storage, and handling.
- D. Section 07 92 00 - Joint Sealants: Emissions-compliant sealants.

1.03 DEFINITIONS

- A. Indoor-Emissions-Restricted Products: All products in the following product categories, whether specified or not:
 - 1. Interior paints and coatings applied on site.
 - 2. Interior adhesives and sealants applied on site, including flooring adhesives.
 - 3. Flooring.
 - 4. Products making up wall and ceiling assemblies.
 - 5. Thermal and acoustical insulation.
 - 6. Other products when specifically stated in the specifications.
- B. VOC-Content-Restricted Products: All products in the following product categories, whether specified or not:
 - 1. Interior paints and coatings applied on site.
 - 2. Interior adhesives and sealants applied on site, including flooring adhesives.
- C. Interior of Building: Anywhere inside the exterior weather barrier.
- D. Adhesives: All gunnable, trowelable, liquid-applied, and aerosol adhesives, whether specified or not; including flooring adhesives, resilient base adhesives, and pipe jointing adhesives.
- E. Sealants: All gunnable, trowelable, and liquid-applied joint sealants and sealant primers, whether specified or not; including firestopping sealants and duct joint sealers.
- F. Inherently Non-Emitting Materials: Products composed wholly of minerals or metals, unless they include organic-based surface coatings, binders, or sealants; and specifically the following:
 - 1. Concrete.
 - 2. Metals that are plated, anodized, or powder-coated.
 - 3. Glass.
 - 4. Ceramics.

1.04 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
- B. ASTM D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings; 2005 (Reapproved 2018).
- C. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.

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Volatile Organic Compound
(VOC) Content Restrictions
01 61 16 - 1

- D. CARB (SCM) - Suggested Control Measure for Architectural Coatings; California Air Resources Board; 2020.
- E. CHPS (HPPD) - High Performance Products Database; Current Edition.
- F. SCAQMD 1113 - Architectural Coatings; 1977, with Amendment (2016).
- G. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).
- H. SCS (CPD) - SCS Certified Products; Current Edition.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: For each VOC-restricted product used in the project, submit evidence of compliance.

1.06 QUALITY ASSURANCE

- A. Indoor Emissions Standard and Test Method: CAL (CDPH SM), using Standard Private Office exposure scenario and the allowable concentrations specified in the method, and range of total VOC's after 14 days.
 - 1. Wet-Applied Products: State amount applied in mass per surface area.
 - 2. Paints and Coatings: Test tinted products, not just tinting bases.
 - 3. Evidence of Compliance: Acceptable types of evidence are the following;
 - a. Current UL (GGG) certification.
 - b. Current SCS (CPD) Floorscore certification.
 - c. Current SCS (CPD) Indoor Advantage Gold certification.
 - d. Current listing in CHPS (HPPD) as a low-emitting product.
 - e. Current CRI (GLP) certification.
 - f. Test report showing compliance and stating exposure scenario used.
 - 4. Product data submittal showing VOC content is NOT acceptable evidence.
 - 5. Manufacturer's certification without test report by independent agency is NOT acceptable evidence.
- B. VOC Content Test Method: 40 CFR 59, Subpart D (EPA Method 24), or ASTM D3960, unless otherwise indicated.
 - 1. Evidence of Compliance: Acceptable types of evidence are:
 - a. Report of laboratory testing performed in accordance with requirements.
 - b. Published product data showing compliance with requirements.
 - c. Certification by manufacturer that product complies with requirements.
- C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All Products: Comply with the most stringent of federal, State, and local requirements, or these specifications.
- B. Indoor-Emissions-Restricted Products: Comply with Indoor Emissions Standard and Test Method, except for:
 - 1. Inherently Non-Emitting Materials.
- C. VOC-Content-Restricted Products: VOC content not greater than required by the following:
 - 1. Adhesives, Including Flooring Adhesives: SCAQMD 1168 Rule.
 - 2. Joint Sealants: SCAQMD 1168 Rule.
 - 3. Paints and Coatings: Each color; most stringent of the following:

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Volatile Organic Compound
(VOC) Content Restrictions
01 61 16 - 2

- a. 40 CFR 59, Subpart D.
- b. SCAQMD 1113 Rule.
- c. CARB (SCM).

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Owner reserves the right to reject non-compliant products, whether installed or not, and require their removal and replacement with compliant products at no extra cost to Owner.
- B. Additional costs to restore indoor air quality due to installation of non-compliant products will be borne by Contractor.

END OF SECTION 01 61 16

**SECTION 01 70 00
EXECUTION AND CLOSEOUT REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Examination, preparation, and general installation procedures.
- B. Requirements for alterations work, including selective demolition.
- C. Pre-installation meetings.
- D. Cutting and patching.
- E. Cleaning and protection.
- F. Starting of systems and equipment.
- G. Demonstration and instruction of Owner personnel.
- H. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.
- I. General requirements for maintenance service.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittals procedures, Electronic document submittal service.
- B. Section 01 40 00 - Quality Requirements: Testing and inspection procedures.
- C. Section 01 50 00 - Temporary Facilities and Controls: Temporary exterior enclosures.
- D. Section 01 50 00 - Temporary Facilities and Controls: Temporary interior partitions.
- E. Section 01 74 19 - Construction Waste Management and Disposal: Additional procedures for trash/waste removal, recycling, salvage, and reuse.
- F. Section 01 78 00 - Closeout Submittals: Project record documents, operation and maintenance data, warranties, and bonds.
- G. Section 01 79 00 - Demonstration and Training: Demonstration of products and systems to be commissioned and where indicated in specific specification sections
- H. Section 01 91 13 - General Commissioning Requirements: Contractor's responsibilities in regard to commissioning.
- I. Section 02 41 00 - Demolition: Demolition of whole structures and parts thereof; site utility demolition.
- J. Section 07 84 00 - Firestopping.
- K. Individual Product Specification Sections:
 - 1. Advance notification to other sections of openings required in work of those sections.
 - 2. Limitations on cutting structural members.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - 1. Structural integrity of any element of Project.
 - 2. Efficiency, maintenance, or safety of any operational element.
 - 3. Visual qualities of sight exposed elements.

4. Work of Owner or separate Contractor.
5. Include in request:
 - a. Identification of Project.
 - b. Location and description of affected work.
 - c. Necessity for cutting or alteration.
 - d. Description of proposed work and products to be used.
 - e. Effect on work of Owner or separate Contractor.
 - f. Written permission of affected separate Contractor.
 - g. Date and time work will be executed.

1.05 PROJECT CONDITIONS

- A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- B. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.

1.06 COORDINATION

- A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Notify affected utility companies and comply with their requirements.
- C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean-up of work of separate sections.
- G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

- A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- C. Notify Architect four days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of examination, preparation and installation procedures.
 - 2. Review coordination with related work.
- E. Record minutes and distribute copies within two days after meeting to participants, with copies to Architect, Owner, participants, and those affected by decisions made.

3.04 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.05 ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of alterations work constitutes acceptance of existing conditions.
- B. Keep areas in which alterations are being conducted separated from other areas that are still occupied.

1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 .
- C. Remove existing work as indicated and as required to accomplish new work.
 1. Remove items indicated on drawings.
 2. Relocate items indicated on drawings.
 3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
 4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.
- D. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
 2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
 3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
 - b. Provide temporary connections as required to maintain existing systems in service.
 4. Verify that abandoned services serve only abandoned facilities.
 5. Remove abandoned pipe, ducts, conduits, and equipment , including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.
- E. Protect existing work to remain.
 1. Prevent movement of structure; provide shoring and bracing if necessary.
 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 3. Repair adjacent construction and finishes damaged during removal work.
- F. Adapt existing work to fit new work: Make as neat and smooth transition as possible.
- G. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
- H. Refinish existing surfaces as indicated:
 1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
 2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
- I. Clean existing systems and equipment.
- J. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.
- K. Do not begin new construction in alterations areas before demolition is complete.

- L. Comply with all other applicable requirements of this section.

3.06 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. See Alterations article above for additional requirements.
- C. Perform whatever cutting and patching is necessary to:
 - 1. Complete the work.
 - 2. Fit products together to integrate with other work.
 - 3. Provide openings for penetration of mechanical, electrical, and other services.
 - 4. Match work that has been cut to adjacent work.
 - 5. Repair areas adjacent to cuts to required condition.
 - 6. Repair new work damaged by subsequent work.
 - 7. Remove samples of installed work for testing when requested.
 - 8. Remove and replace defective and non-complying work.
- D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- F. Restore work with new products in accordance with requirements of Contract Documents.
- G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.
- I. Patching:
 - 1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
 - 2. Match color, texture, and appearance.
 - 3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.07 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.08 PROTECTION OF INSTALLED WORK

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.

- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.09 SYSTEM STARTUP

- A. Coordinate with requirements of Section 01 91 13 - General Commissioning Requirements.
- B. Coordinate schedule for start-up of various equipment and systems.
- C. Notify Architect and Owner seven days prior to start-up of each item.
- D. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
- E. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

3.10 DEMONSTRATION AND INSTRUCTION

- A. See Section 01 79 00 - Demonstration and Training.

3.11 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.12 FINAL CLEANING

- A. Use cleaning materials that are nonhazardous.
- B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- E. Clean filters of operating equipment.
- F. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.13 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
- B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's comprehensive list of items to be completed or corrected.
- C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.
- D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.

- E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.
- F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
- G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.
- H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

3.14 MAINTENANCE

- A. Provide service and maintenance of components indicated in specification sections.
- B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.
- C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.
- E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

END OF SECTION 01 70 00

SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

- A. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.
- B. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.
- C. Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.
- D. Methods of trash/waste disposal that are not acceptable are:
 - 1. Burning on the project site.
 - 2. Burying on the project site.
 - 3. Dumping or burying on other property, public or private.
 - 4. Other illegal dumping or burying.
- E. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.
- B. Section 01 50 00 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.
- C. Section 01 60 00 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.
- D. Section 01 70 00 - Execution and Closeout Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

1.03 DEFINITIONS

- A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.
- B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.
- C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.
- D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.
- E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.
- F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
- G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

- H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- I. Return: To give back reusable items or unused products to vendors for credit.
- J. Reuse: To reuse a construction waste material in some manner on the project site.
- K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.
- L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
- M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
- N. Toxic: Poisonous to humans either immediately or after a long period of exposure.
- O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
- P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Submit Waste Management Plan within 10 calendar days after receipt of Notice of Award of Bid, or prior to any trash or waste removal, whichever occurs sooner; submit projection of all trash and waste that will require disposal and alternatives to landfilling.
- C. Waste Management Plan: Include the following information:
 - 1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
 - 2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
 - 3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
 - 4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
 - 5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
 - 6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.

PART 3 EXECUTION

2.01 WASTE MANAGEMENT PROCEDURES

- A. See Section 01 30 00 for additional requirements for project meetings, reports, submittal procedures, and project documentation.
- B. See Section 01 50 00 for additional requirements related to trash/waste collection and removal facilities and services.
- C. See Section 01 60 00 for waste prevention requirements related to delivery, storage, and handling.

- D. See Section 01 70 00 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

2.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

- A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.
- B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.
- C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.
- D. Meetings: Discuss trash/waste management goals and issues at project meetings.
 - 1. Prebid meeting.
 - 2. Preconstruction meeting.
- E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
 - 1. Provide containers as required.
 - 2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
 - 3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.
- F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.
- G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

END OF SECTION 01 74 19

**SECTION 01 78 00
CLOSEOUT SUBMITTALS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project record documents.
- B. Operation and maintenance data.
- C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- B. Section 01 70 00 - Execution and Closeout Requirements: Contract closeout procedures.
- C. Individual Product Sections: Specific requirements for operation and maintenance data.
- D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
- B. Operation and Maintenance Data:
 - 1. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 2. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned, with Architect comments. Revise content of all document sets as required prior to final submission.
 - 3. Submit two sets of revised final documents in final form within 10 days after final inspection.
- C. Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed shop drawings, product data, and samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.

- D. Record information concurrent with construction progress.
- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Field changes of dimension and detail.
 - 2. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- A. For Each Product, Applied Material, and Finish:
 - 1. Product data, with catalog number, size, composition, and color and texture designations.
 - 2. Information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
- C. Additional information as specified in individual product specification sections.
- D. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
- B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.
- C. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- D. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- E. Include manufacturer's printed operation and maintenance instructions.

- F. Include sequence of operation by controls manufacturer.
- G. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- H. Provide control diagrams by controls manufacturer as installed.
- I. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.
- J. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- K. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- L. Include test and balancing reports.
- M. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

- A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
- B. Where systems involve more than one specification section, provide separate tabbed divider for each system.
- C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.
- F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.
- G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.
- H. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.
- I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- J. Arrangement of Contents: Organize each volume in parts as follows:
 - 1. Project Directory.
 - 2. Table of Contents, of all volumes, and of this volume.
 - 3. Operation and Maintenance Data: Arranged by system, then by product category.
 - a. Source data.
 - b. Operation and maintenance data.
 - c. Field quality control data.
 - d. Photocopies of warranties and bonds.

3.06 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Co-execute submittals when required.
- D. Retain warranties and bonds until time specified for submittal.
- E. Include originals of each in operation and maintenance manuals, indexed separately on Table of Contents.
- F. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.
- G. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.
- H. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.
- I. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

END OF SECTION 01 78 00

**SECTION 01 79 00
DEMONSTRATION AND TRAINING**

PART 1 GENERAL

1.01 SUMMARY

- A. Demonstration of products and systems where indicated in specific specification sections.
- B. Training of Owner personnel in operation and maintenance is required for:
 - 1. All software-operated systems.
 - 2. HVAC systems and equipment.
 - 3. Plumbing equipment.
 - 4. Electrical systems and equipment.
 - 5. Items specified in individual product Sections.
- C. Training of Owner personnel in care, cleaning, maintenance, and repair is required for:
 - 1. Finishes, including flooring, wall finishes, ceiling finishes.
 - 2. Fixtures and fittings.
 - 3. Items specified in individual product Sections.

1.02 RELATED REQUIREMENTS

- A. Section 01 78 00 - Closeout Submittals: Operation and maintenance manuals.
- B. Section 01 91 13 - General Commissioning Requirements: Additional requirements applicable to demonstration and training.
- C. Other Specification Sections: Additional requirements for demonstration and training.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
 - 1. Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Authority.
 - 2. Submit one copy to the Commissioning Authority, not to be returned.
 - 3. Make commissioning submittals on time schedule specified by Commissioning Authority.
- B. Training Plan: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
 - 1. Submit to Architect for transmittal to Owner.
 - 2. Submit to Commissioning Authority for review and inclusion in overall training plan.
 - 3. Submit not less than four weeks prior to start of training.
 - 4. Revise and resubmit until acceptable.
 - 5. Provide an overall schedule showing all training sessions.
 - 6. Include at least the following for each training session:
 - a. Identification, date, time, and duration.
 - b. Description of products and/or systems to be covered.
 - c. Name of firm and person conducting training; include qualifications.
 - d. Intended audience, such as job description.
 - e. Objectives of training and suggested methods of ensuring adequate training.
 - f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
 - g. Media to be used, such as slides, hand-outs, etc.
 - h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
- C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
 - 1. Include applicable portion of O&M manuals.

2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
 3. Provide one extra copy of each training manual to be included with operation and maintenance data.
- D. Training Reports:
1. Identification of each training session, date, time, and duration.
 2. Sign-in sheet showing names and job titles of attendees.
 3. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.
- E. Video Recordings: Submit digital video recording of each demonstration and training session for Owner's subsequent use.
1. Format: DVD Disc.
 2. Label each disc and container with session identification and date.

1.04 QUALITY ASSURANCE

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
 2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.
- B. Demonstration may be combined with Owner personnel training if applicable.
- C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
1. Perform demonstrations not less than two weeks prior to Substantial Completion.
 2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

- A. Conduct training on-site unless otherwise indicated.
- B. Provide training in minimum two hour segments.
- C. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.
- D. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
1. The location of the O&M manuals and procedures for use and preservation; backup copies.

2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
 3. Typical uses of the O&M manuals.
- E. Product- and System-Specific Training:
1. Review the applicable O&M manuals.
 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
 4. Provide hands-on training on all operational modes possible and preventive maintenance.
 5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
 6. Discuss common troubleshooting problems and solutions.
 7. Discuss any peculiarities of equipment installation or operation.
 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
 10. Review spare parts and tools required to be furnished by Contractor.
 11. Review spare parts suppliers and sources and procurement procedures.
- F. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION 01 79 00

**SECTION 01 91 00
GENERAL COMMISSIONING REQUIREMENTS**

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes general requirements that apply to the implementation of the Commissioning Process and the contractors' participation in this process. Commissioning is a systematic process to provide documented confirmation that the facility's systems perform according to the criteria set forth in the design documents and satisfy the Owner's Project Requirements. This is achieved by documenting the Owner's Project Requirements, the Basis of Design; and continuing throughout construction, acceptance and the warranty period, including actual verification of system performances. The Commissioning Process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning facility.

1.02 RELATED DOCUMENTS

- A. The Owner's Project Requirements (OPR) document.
- B. The Basis of Design (BoD) document.
- C. The Commissioning Plan; which details team members; commissioning work tasks, sequence, and schedule; and quality assurance requirements.
- D. ASHRAE Standard 202-2013 - Commissioning Process for Buildings and Systems

1.03 RELATED SECTIONS

- A. SECTION 22 08 00 - COMMISSIONING OF PLUMBING SYSTEMS
- B. SECTION 23 08 00 - COMMISSIONING OF HVAC SYSTEMS
- C. SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

1.04 SYSTEMS TO BE COMMISSIONED

- A. The following outline of commissioning requirements by Division is provided as a guideline for Contractor, sub-Contractors, and CxA to understand the nature and extent of commissioning work, so that resources may be properly allocated.
- B. Commissioning specifications supplement requirements of individual specifications sections, but shall not be interpreted to replace or diminish the specified scope of any individual section.
- C. For all systems listed below, Contractor and Subcontractors shall comply with all commissioning requirements specified.
- D. Though listed as separate systems to be commissioned, systems listed below may be commissioned as a part of another system, as opposed to being commissioned separately.
- E. Applicable Systems:
 - 1. Division 22 Plumbing Systems: For a list of systems which shall be commissioned, refer to Section 22 08 00.
 - 2. Division 23 Mechanical Systems: For a list of systems which shall be commissioned, refer to Section 23 08 00.
 - 3. Division 26 Electrical Systems: For a list of systems which shall be commissioned, refer to Section 26 08 00.

1.05 DEFINITIONS

- A. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in tested modes according to Contract Documents.

- B. Basis of Design (BoD): Documentation of primary thought processes and assumptions behind design decisions that were made to meet design intent and satisfy applicable regulatory requirements, standards, and guidelines. Describes systems, components, conditions, and methods chosen to meet intent. The document includes both narrative descriptions and lists of individual items that support the design process.
- C. Commissioning Agent (CxA): Independent agent hired by Owner and not associated with Contractor, subcontractors, Architect, Consultants, or Construction Administrator or its staff or consultants. Under Owner's direction, the CxA will direct and coordinate day-to-day commissioning activities without assuming product or installation liability.
- D. Commissioning Process (Cx): A process that coordinates the traditionally separate functions of system documentation, equipment start-up, control system calibration, testing and balancing, training and performance testing. Commissioning requirements do not supersede other requirements of the specifications, but may expand on some of them.
- E. Commissioning Team (CXT): Consists of the Owner or Owner's Representative, Commissioning Agent, Design Team, Contractors, Subcontractors, and Vendors.
- F. Facility Commissioning: A joint team effort to ensure that all mechanical equipment, controls, and systems function together properly to meet the design intent, to document system performance parameters and to ensure that personnel are adequately trained to operate systems.
- G. Functional Performance Test (FPT): Documentation provided and executed by the CxA, with the assistance of the respective contractor or vendor. Testing of the complete systems, as opposed to components, under full operation in various modes through all automatic and manual control sequences of operation using direct observation and monitoring methodology following prescribed test procedures in sequential written form.
- H. Logger: Independent monitoring device. Used for verification of proper system operation.
- I. Owner's Project Requirements (OPR): A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- J. Pre-Functional Checklist (PFC): Documentation provided by the CxA and executed by the contractor. A checklist of items to inspect and component-level tests, to verify proper installation of equipment prior to functional testing.
- K. Sampling: Functional testing only a fraction of the total number of identical pieces of equipment.
- L. Seasonal Testing: Testing of equipment, which can be done only during periods of peak heating or cooling, when equipment is operating at full-load conditions.
- M. Simulated Condition: Artificially altering the normal operating conditions of equipment or systems, for the purpose of testing the proper response of systems.
- N. Trending: System monitoring using the Energy Management and Control System.

1.06 RESPONSIBILITIES

- A. The Commissioning Agent: Responsibilities of the CxA include, but are not limited to the following:
 - 1. Coordinate and direct each step of the Commissioning Process for systems being commissioned for this project. Coordinate commissioning work schedule with Project Manager and/or Contractor.
 - 2. Attend planning and job-site meetings as required to obtain information relating to Commissioning Process.

3. Plan and conduct commissioning scoping and coordination meetings. Provide notice to all Team members to attend scheduled commissioning meetings.
 4. Ensure all information required for Commissioning Process from manufacturers, Contractors, and A/E design team is available.
 5. Review A/E design documents to gain clear understanding of design intent.
 6. Review Contractor submittals for compliance with commissioning needs.
 7. Verify that systems and equipment have been installed and started in accordance with manufacturer's recommendations and with generally recognized construction standards and that documentation of such has been provided.
 8. Prepare Pre-Functional Checklists to ensure systems have been installed according to project specifications. Verify that Pre-Functional Checklists have been completed by Contractor and are accurate.
 9. Prepare Functional Performance Testing procedures to demonstrate performance of systems according to project specifications. Observe and document performance of systems, as per process detailed in Functional Test procedures.
 10. Review Testing and Balancing (TAB) reports, notify Design Team of deficiencies.
 11. Recommend acceptance or non-acceptance of systems to Owner.
 12. Verify that Operations and Maintenance (O&M) documentation is complete. Operations and Maintenance manuals shall be submitted simultaneously to CxA and to Design Team for review.
 13. Verify that Owner training is completed for all systems to be commissioned.
 14. Compile and maintain Commissioning Issues Log.
 15. Provide Final Commissioning Report to Owner.
- B. Contractor: Responsibilities of the Contractor as relate to Commissioning Process include, but are not limited to the following:
1. Facilitate coordination of commissioning work by Cx Team. At the Owner's discretion, Commissioning work will be documented using third party, web-based software. Direct interaction with the software by contractor's field personnel requires end user devices, such as lap-top, tablet etc.
 2. All costs associated with the participation of Contractor, Sub-Contractors, and Equipment Vendors in the Commissioning Process shall be included in the scope of this contract.
 3. Attend Commissioning meetings or other meetings called by CxA to facilitate the Commissioning Process.
 4. Review Functional Testing procedures for feasibility, safety, and impact on warranty, and provide CxA with written comment on same.
 5. Provide all documentation relating to manufacturer's recommended performance testing of equipment and systems.
 6. Provide Operations and Maintenance Data to CxA for preparation of checklists and training manuals.
 7. Provide testing and balancing report.
 8. Assure and facilitate participation and cooperation of subcontractors (electrical, mechanical, controls, etc.) and equipment suppliers as required for the Commissioning Process.
 9. Certify to CxA that installation work listed in Pre-Functional Checklists has been completed.
 10. Install systems and equipment in strict conformance with project specifications, manufacturer's recommended installation procedures, and Pre-Functional Checklists, as prepared by CxA.
 11. Provide data concerning performance, installation, and start-up of systems.
 12. Provide copy of manufacturer completed start-up forms for equipment and systems.

13. Ensure systems have been started and fully checked for proper operation prior to arranging for Functional Testing with CxA. Prepare and submit to CxA written certification that each piece of equipment and/or system has been started according to manufacturer's recommended procedure, and that system has been tested for compliance with operational requirements.
 - a. Contractor shall carry out manufacturer's recommended start-up and testing procedures, regardless of whether or not they are specifically listed in Functional Test procedures.
 - b. Contractor is not relieved of obligation for systems/equipment demonstration where performance testing is required by specifications, but a Functional Performance Test is not specifically designated by CxA.
 14. Coordinate with CxA to determine mutually acceptable date of Functional Performance Tests.
 15. Provide test instruments and communications devices, as prescribed by CxA, required for carrying out Functional Testing of systems.
 16. Ensure deficiencies shown in the Commissioning Issues Log are corrected within the time allowed for the project.
 17. Provide CxA with all submittals, start-up instructions manuals, operating parameters, and other pertinent information related to Commissioning Process.
 18. Prepare and submit to CxA proposed Training Program outline for each system.
 19. Coordinate and provide training of Owner's personnel.
 20. Prepare Operation and Maintenance manuals and As-Built drawings in accordance with specifications; submit copy to CxA in addition to other contractually required submissions. Revise and resubmit manuals in accordance with A/E and CxA's comments.
- C. Subcontractors and Vendors:
1. Shall prepare and submit to Commissioning Agent proposed Installation and Startup procedures, to demonstrate performance of systems according to these specifications.
 2. Shall execute pre-functional checklists for appropriate equipment and systems. At the Owner's discretion, Commissioning work will be documented using third party, web-based software. Direct interaction with the software by contractor's field personnel requires end user devices, such as lap-top, tablet etc.
- D. Owner's Representative: Responsibilities of the Owner's Representative as related to Commissioning Process include, but are not limited to the following:
1. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.
 2. Provide final approval for completion of commissioning work.
 3. Ensure that seasonal or deferred testing and deficiency issues are addressed.
- E. Architect: Responsibilities of the Architect as related to the Commissioning Process shall include, but are not limited to the following:
1. Attend commissioning scoping meeting and other commissioning team meetings as requested by Commissioning Agent.
 2. Perform normal submittal review, construction observation, record drawing preparation, and operations and maintenance data preparation, as required by Contract Documents.
 3. Provide design narrative documentation requested by Commissioning Agent.
 4. Coordinate resolution of system deficiencies identified during commissioning, as required by Contract Documents.
 5. Prepare and submit final as-built design intent documentation for inclusion in Operation and Maintenance Data Manual, and review and approve Operation and Maintenance Data Manual.

6. Warranty Period: Coordinate resolution of design non-conformance and design deficiencies identified during warranty period commissioning.
- F. Mechanical, Electrical, Plumbing, Automation, and Specialty Engineers: Responsibilities of the Engineers as related to the Commissioning Process shall include, but are not limited to the following:
 1. Perform detailed submittal review, construction observations, and record drawing preparation, as required by Contract Documents. Perform site observation immediately preceding system startup.
 2. Provide design narrative and sequence documentation requested by Commissioning Agent. Assist in clarifying operation and control of commissioned equipment in areas where specifications, control drawings, or equipment documentation are not sufficient for writing detailed testing procedures.
 3. Attend commissioning scoping meetings and other commissioning team meetings as requested by Commissioning Agent.
 4. Participate in resolution of system deficiencies identified during commissioning, as required by Contract Documents.
 5. Prepare and submit final as-built design intent and operating parameters documentation for inclusion in Operation and Maintenance Manual, and review and approve Operation and Maintenance Manual.

PART 2 PRODUCTS

2.01 NO PRODUCTS SUPPLIED

- A. Contractors and/or Vendors shall provide specialty testing equipment necessary to fulfill functional testing requirements, for the duration of the testing period.

PART 3 EXECUTION

3.01 GENERAL

- A. Contractor shall coordinate with sub-contractors and equipment vendors to set aside adequate time to address Pre-Functional Checklist execution, Functional Testing, Operations and Maintenance Training, and associated coordination meetings.
- B. CxA may also conduct site inspections at critical times and issue Cx Field Reports with observations on installation deficiencies so that they may be addressed by appropriate contractor.

3.02 MEETINGS

- A. A commissioning team scoping meeting shall be held at a time and place agreed upon shortly after the beginning of the construction phase of the project. Owner, Commissioning Agent, General Contractor, Architect, Mechanical Subcontractor, and Electrical Subcontractor shall be present at this meeting. The purpose of the meeting is to familiarize all parties with the requirements of the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
- B. Separate meetings including individual equipment suppliers and subcontractors shall be held prior to commissioning of their systems at the discretion of CxA.
- C. Miscellaneous Meetings. The CxA shall plan and conduct other meetings as required as construction progresses. Meetings will cover coordination, deficiency resolution, and planning issues with particular subcontractors. CxA will plan meetings to minimize unnecessary time being spent by subcontractors.

3.03 SYSTEM START-UP

- A. Contractor will arrange for start-up of operating equipment and systems prior to scheduling Functional Testing.
- B. Start-up of equipment and systems shall be performed only by a manufacturer's representative, or person(s) who are specifically manufacturer-approved. All start-up personnel shall be trained and authorized, experienced and knowledgeable in the operations of such equipment and systems.
- C. Coordinate schedule for start-up of various equipment and systems so that subsystems required for major systems operation are tested first.
- D. Manufacturer's start-up reports must be submitted to CxA prior to scheduling Functional Testing.

3.04 PRE-FUNCTIONAL CHECKLISTS

- A. Pre-Functional Checklists are important to ensure that equipment and systems are properly connected and installed in accordance with specifications, drawings, manufacturer's requirements, and all applicable codes.
- B. Checklists ensure that functional performance testing may proceed without unnecessary delays.
- C. Completion of PFCs shall be executed by subcontractor or vendor. Only individuals that have direct knowledge and who witnessed that line item task on PFC was performed shall initial item.
- D. Each piece of equipment receives pre-functional checklist form. No sampling strategies are used.
- E. PFC for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of given system.
- F. Pre-functional tasks shall be documented in a checklist format, as prepared and provided by CxA, for each piece of equipment. Each checklist shall be initialed by Contractor.
- G. CxA provided PFCs shall not preclude Contractor from applying his own construction inspection checklists and quality control.
- H. All system elements shall be checked to verify that they have been installed, adjusted, and calibrated properly, that all connections have been made correctly, and that it is ready to function as specified. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, control sequence, and other conditions which may cause damage.
- I. Verify that tests, meter readings and specific electrical characteristics agree with those required by equipment or system manufacturer.
- J. All discrete elements and sub-systems shall be adjusted and shall be checked for proper operation. Verify wiring and support components for equipment are complete and tested.
- K. Conduct start-up procedure recommended by equipment/system manufacturer.
- L. Subcontractors shall clearly list outstanding items of initial start-up and pre-functional procedures that were not completed successfully at bottom of procedures form or on separate sheet attached to form. Completed form and attached sheets shall be provided to Commissioning Agent within 2 days of completion. Installing subcontractor or vendor shall correct deficient or incomplete areas in timely manner and shall submit updated pre-functional checklist and startup report with statement of correction on original non-compliance report.

3.05 FUNCTIONAL PERFORMANCE TESTING

- A. The objective of Functional Performance Testing is to demonstrate that each system is operating according to documented design intent and Contract Documents, through all possible modes of operation.
- B. Contractors and vendors shall include in their bid proposal all costs associated with participation in the execution of Testing Procedures for all items listed in Part 4 of this specification.
- C. Functional Testing is intended to begin upon completion of each system. Functional Testing may proceed prior to completion of systems or sub-systems at discretion of Commissioning Agent. Initiation of system testing, before completion, does not relieve Contractor from fully completing system, including pre-functional checklists as early as possible.
- D. Testing shall be conducted under specified operating conditions as recommended or approved by Commissioning Agent.
- E. A Functional Performance Test shall be performed on each complete system. Each function shall be demonstrated to the satisfaction of Commissioning Agent in accordance with proposed test procedures developed to demonstrate compliance with specifications.
- F. Each Functional Test shall be witnessed and signed off by Owner's Representative and Commissioning Agent upon satisfactory completion.
- G. All elements of system shall be tested to demonstrate that total systems satisfy all requirements of these specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each subsystem, followed by the entire system, followed by any inter-ties to other major systems.
- H. All major testing materials and equipment shall be provided by contractor.
- I. Notification, scheduling of functional testing and re-testing
 1. Notify CxA and Owner, in writing, of request for scheduling Functional Testing. Submit request no fewer than five (5) business days prior to desired day of testing.
 - a. Contractor must certify that systems and equipment are functioning satisfactorily, according to specifications and design intent, prior to requesting Functional Testing. Upon receipt of such certification, CxA will schedule with Contractor a time for the particular system test.
 - b. CxA will attempt to schedule Functional Testing when convenient for Contractor and his vendors, and to minimize lost time to Contractor.
 - c. Contractor will resolve all deficiencies identified during initial test prior to submitting request, in writing, for re-testing. Such request for re-testing shall certify that Contractor has resolved all deficiencies, or list reason why any deficiencies remain which cannot be resolved.
 - d. CxA will re-test to ensure that all deficiencies have been resolved.
 - e. Deficiencies that were not detected in first Functional Test, but are discovered in subsequent re-testing, are to be resolved by Contractor as if they had been discovered in initial testing.
- J. Functional Testing Requirements And Procedures
 1. Contractor and Subcontractors shall perform tests in the presence of CxA. Tests not witnessed by CxA shall not be considered complete.
 2. To facilitate Functional Testing, when requested by CxA, Contractor shall provide services of personnel to accompany CxA for the duration of Functional Testing, including any follow-up testing. Such personnel must be experienced, qualified, and intimately familiar with the system being tested.

- a. Participation by representatives of the EMCS contractor is of particular importance in Functional Testing. All systems which are controlled and / or monitored by the EMCS are to be thoroughly tested, point by point, through all modes of operation, with the assistance of the Contractor's representative. Graphics, setpoints, and programming are to be included as a part of Functional Testing as well.
 - b. Contractors must provide services of personnel to accompany CxA for equipment and systems which may pose particular health and safety concerns, such as steam boilers.
 - c. Should he fail to provide representative to accompany CxA during Functional Testing, Contractor continues to bear full responsibility for equipment warranty. Owner and CxA will not be held responsible for damage to equipment, or other actions which might impact warranty, when performing Functional Testing of systems where Contractor has not provided authorized accompanying representative to operate equipment.
 3. Each system shall be operated through all modes of operation including, but not limited to seasonal, occupied, unoccupied, warm-up, cool-down, part-load, and full-load, where system response is specified.
 - a. For multiple units, sampling strategy established by Commissioning Agent and subject to approval of Owner may be used.
 - b. Verification of each sequence in Sequence of Operations is required.
 - c. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, and the like, shall also be tested.
 4. Functional Testing is to be dedicated solely to testing of equipment and systems, and not to resolution of deficiencies. Deficiencies identified during testing process must be corrected by Contractor at a time other than during Functional Testing.
 5. CxA shall issue test reports with readings and checklists and a listing of any deficiencies that must be addressed by Contractor or sub-Contractors.
 6. Commissioning Agent shall submit a Final Report to Owner recommending acceptance or non-acceptance of individual system components as well as the systems as a whole.
- K. Re-Testing And Failure To Remedy Deficiencies
1. It is expected that some deficiencies will be found during initial inspection and during Functional Testing; such deficiencies are expected to be minimal.
 2. It is Contractor's responsibility to remedy identified deficiencies, both in Pre-Functional and in Functional Testing phases of work, in a timely and thorough manner.
 3. It is Contractor's responsibility to ensure that all deficiencies are corrected prior to requesting a re-inspection or re-test of systems and equipment. Do not request re-inspection or re-test until deficiencies are corrected.
 - a. CxA may agree to re-testing systems or equipment where deficiencies remain, which are beyond Contractor's control to resolve expeditiously.
 - b. Typically such re-testing of incomplete systems and equipment will take place only if remaining deficiencies are minor in scope and nature, and are of such nature that they cannot be resolved in a timely manner.
 4. CxA will carry out a second re-inspection or re-test of systems and equipment subsequent to receiving Contractor's request.
 - a. If CxA finds deficiencies identified in initial inspection or test have not been remedied and such remaining deficiencies are significant enough to require additional inspection or re-testing, Contractor will be back-charged for CxA's expenses and time, at a rate of \$200 per hour, for a third and any subsequent re-inspections and re-tests.

3.06 TRAINING

A. Scheduling

1. Provide a proposed schedule and outline of training of Owner's personnel for Commissioning Agent's review approximately 30 days before project completion. The Commissioning Agent will review the submittal.
2. Submit revised outline and fully developed training materials for review by Commissioning Agent, 10 business days prior to scheduled training sessions.
3. Organize training to fit Owner's schedule and to optimize the learning experience. Limit continuous sessions to no more than three hours at a time, or otherwise only as approved by Owner and/or Architect/Engineer.

B. Training Materials

1. Develop Training Manuals to meet requirements of individual equipment specification sections.
2. Operating and Maintenance Manuals alone are NOT considered training manuals. O&M Manuals may be used as reference, but shall not be considered to meet requirements for training materials.
3. Develop a detailed outline showing how training program will be organized, including classroom and hands-on training as required by individual specifications sections.
4. Provide with training materials, a quick-reference "how-to" index which will allow operators to easily access information included in Training Manuals and/or O&M Manuals. This reference will include, as a minimum; routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions.
5. Refer to individual equipment or system specifications for minimum material to be covered as part of the training program.

END OF SECTION 01 91 00 01 91 00

**SECTION 02 41 00
DEMOLITION**

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: Limitations on Contractor's use of site and premises.
- B. Section 01 10 00 - Summary: Sequencing and staging requirements.
- C. Section 01 10 00 - Summary: Description of items to be salvaged or removed for re-use by Contractor.
- D. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- E. Section 01 57 13 - Temporary Erosion and Sediment Control.
- F. Section 01 60 00 - Product Requirements: Handling and storage of items removed for salvage and relocation.
- G. Section 01 70 00 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.
- H. Section 07 01 50.19 - Preparation for Re-Roofing: Removal of existing roofing, roof insulation, flashing, trim, and accessories.
- I. Section 31 10 00 - Site Clearing: Vegetation and existing debris removal; earth stripping and stockpiling.
- J. Section 31 22 00 - Grading: Rough and fine grading.
- K. Section 31 23 23 - Fill: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

1.02 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2022, with Errata (2021).

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Site Plan: Indicate:
 - 1. Vegetation to be protected.
 - 2. Areas for temporary construction and field offices.
 - 3. Areas for temporary and permanent placement of removed materials.
- C. Demolition Plan: Submit demolition plan as required by OSHA and local AHJs.
 - 1. Indicate extent of demolition, removal sequencing, bracing and shoring, and location and construction of barricades and fences.
 - 2. Demolition firm qualifications.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

PART 3 EXECUTION

2.01 DEMOLITION

- A. Remove portions of existing buildings in the sequence noted on the drawings
- B. Remove paving and curbs required to accomplish new work.

- C. Within area of new construction remove foundation walls and footings to a minimum of 2 feet below walls or footings.
- D. Outside area of new construction, remove foundation walls and footings to minimum 2 feet below finished grade.
- E. Remove concrete slabs on grade within site boundaries.
- F. Remove manholes and manhole covers, curb inlets and catch basins.
- G. Remove creosote-treated wood utility poles.
- H. Remove other items indicated, for salvage, relocation, and recycling.
- I. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as specified in Section 31 22 00.

2.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 3. Provide, erect, and maintain temporary barriers and security devices.
 - 4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 5. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
 - 6. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
 - 7. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.
- B. Do not begin removal until receipt of notification to proceed from Owner.
- C. Protect existing structures and other elements to remain in place and not removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger.
- D. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

2.03 EXISTING UTILITIES

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

- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.
- H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone. Identify and mark, in same manner as other utilities to remain, utilities to be reconnected.

2.04 DEBRIS AND WASTE REMOVAL

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

END OF SECTION 02 41 00

SECTION 03 05 16
UNDERSLAB VAPOR BARRIER - STEGO

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sheet vapor barrier under portions of new concrete slabs on grade to replace removed concrete slab on grade to allow for routing of new piping or conduit below slab.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Preparation of subgrade, granular fill, placement of concrete. See structural drawings.

1.03 REFERENCE STANDARDS

- A. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2018a.
- B. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products.
- C. Test Data: Submit report of tests showing compliance with specified requirements.
- D. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent construction.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Underslab Vapor Barrier:
 - 1. Water Vapor Permeance: Not more than 0.010 perms, maximum.
 - 2. Complying with ASTM E1745 Class A.
 - 3. Thickness: 15 mils.minimum
 - 4. Basis of Design:
 - a. Stego Industries LLC; Stego Wrap Vapor Barrier (15-mil):
www.stegoindustries.com/#sle.
 - b. Perminator 15 , manufactured by W.R. Meadows..
 - c. Vapor Block 15, manufactured by Raven Industries.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ACCESSORY PRODUCTS: VAPOR BARRIER MANUFACTURER'S RECOMMENDED TAPE, ADHESIVE, MASTIC, ETC., FOR SEALING SEAMS AND PENETRATIONS IN VAPOR BARRIER.

- A. Seams:
 - 1. Stego Tape by Stego Industries LLC, (877) 464-7834 www.stegoindustries.com.
- B. Sealing Penetrations of Vapor barrier:
 - 1. Stego Mastic by Stego Industries LLC, (877) 464-7834 www.stegoindustries.com.
 - 2. Stego Tape by Stego Industries LLC, (877) 464-7834 www.stegoindustries.com.
- C. Perimeter/edge seal:
 - 1. Stego Crete Claw by Stego Industries LLC, (877) 464-7834 www.stegoindustries.com.
 - 2. Stego Term Bar by Stego Industries LLC, (877) 464-7834 www.stegoindustries.com.

3. StegoTack Tape (double-sided sealant tape) by Stego Industries LLC, (877) 464-7834 www.stegoindustries.com.
- D. Penetration Prevention:
 1. Beast Foot by Stego Industries LLC, (877) 464-7834 www.stegoindustries.com.
 2. Beast Form Stake by Stego Industries LLC, (877) 464-7834 www.stegoindustries.com.
- E. Vapor Barrier-Safe Screed System
 1. Beast Screed by Stego Industries, LLC, (877) 464-7834 www.stegoindustries.com.
 2. Beast Hook by Stego Industries, LLC, (877) 464-7834 www.stegoindustries.com.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surface over which vapor barrier is to be installed is complete and ready before proceeding with installation of vapor barrier.

3.02 INSTALLATION

- A. Install vapor barrier in accordance with manufacturer's instructions and ASTM E1643.
- B. Install vapor barrier under interior slabs on grade; lap sheet over footings and seal to foundation walls.
- C. Lap joints minimum 6 inches.
- D. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions.
- E. No penetration of vapor barrier is allowed except for reinforcing steel and permanent utilities.
- F. Repair damaged vapor retarder before covering with other materials.

END OF SECTION 03 05 16

**SECTION 05 50 00
METAL FABRICATIONS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop fabricated steel and aluminum items.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Placement of metal fabrications in concrete. See structural drawings.
- B. Section 05 51 33 - Metal Ladders.
- C. Section 09 90 00 - Painting and Coating.

1.03 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.
- B. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- 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 A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.
- G. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- H. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.
- I. ASTM B210/B210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes; 2019a.
- J. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire; 2019.
- K. ASTM B210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes; 2012.
- L. ASTM B210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes (Metric); 2012.
- M. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- N. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
- O. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- P. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2014, with Errata (2020).
- Q. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.
- R. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.
- S. SSPC-SP 2 - Hand Tool Cleaning; 2018.

1.04 SUBMITTALS

- A. See Section 01 30 00 - 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. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
- D. 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.

1.05 QUALITY ASSURANCE

- A. Design under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M and dated no more than 12 months before start of scheduled welding work.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.
- C. Plates: ASTM A283/A283M.
- D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.
- E. Mechanical Fasteners: Same material as or compatible with materials being fastened; type consistent with design and specified quality level.
- F. Bolts, Nuts, and Washers: ASTM A307, Grade A, plain.
- G. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- H. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- I. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 MATERIALS - ALUMINUM

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.
- B. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210/B210M, 6063 alloy, T6 temper.
- C. Aluminum-Alloy Bars: ASTM B211/B211M, 6061 alloy, T6 temper.
- D. Bolts, Nuts, and Washers: Stainless steel.
- E. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.

2.03 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. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

- E. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.04 FABRICATED ITEMS

2.05 FINISHES - STEEL

- A. Prime paint steel items.
 - 1. Exceptions: Galvanize items to be embedded in concrete and items to be embedded in masonry.
 - 2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- D. Prime Painting: One coat.
- E. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating.
- F. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.

2.06 FINISHES - ALUMINUM

- A. Exterior Aluminum Surfaces: superior performance organic coating.
- B. Interior Aluminum Surfaces: Class I natural anodized.
- C. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.
- D. Superior Performance Organic Coating System: AAMA 2605 multiple coat, thermally cured polyvinylidene fluoride system; color as indicated.
 - 1. Manufacturers:
 - a. PPG; Duranar: www.ppgmetalcoatings.com/#sle.
 - b. Sherwin-Williams Company; Fluropon: www.coil.sherwin.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.07 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch.
- C. Maximum Misalignment of Adjacent Members: 1/16 inch.
- D. Maximum Bow: 1/8 inch in 48 inches.
- E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 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.

- D. After erection, prime welds, abrasions, and surfaces not shop primed , except surfaces to be in contact with concrete.

3.03 TOLERANCES

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

END OF SECTION 05 50 00

**SECTION 05 51 33
METAL LADDERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Prefabricated ship ladders.

1.02 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.
- B. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements; 2008 (Reaffirmed 2018).
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.
- F. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- G. ASTM B26/B26M - Standard Specification for Aluminum-Alloy Sand Castings; 2018, with Editorial Revision.
- H. ASTM B85/B85M - Standard Specification for Aluminum-Alloy Die Castings; 2018, with Editorial Revision.
- I. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- J. ASTM B210/B210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes; 2019a.
- K. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire; 2019.
- L. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
- M. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- N. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2014, with Errata (2020).
- O. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.
- P. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
- 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. Designer's Qualification Statement.

1.04 QUALITY ASSURANCE

- A. Design ships ladder under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.

- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M and dated no more than 12 months before start of scheduled welding work.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Plates: ASTM A283/A283M.
- C. Mechanical Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Bolts, Nuts, and Washers: ASTM A307, plain.
- E. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- F. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- G. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 MATERIALS - ALUMINUM

- A. Extruded Aluminum: ASTM B211/B211M, 6063 alloy, T6 temper.
- B. Sheet Aluminum: ASTM B209/B209M, 5052 alloy, H32 or H22 temper.
- C. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210/B210M, 6063 alloy, T6 temper.
- D. Aluminum-Alloy Bars: ASTM B211/B211M, 6061 alloy, T6 temper.
- E. Aluminum-Alloy Sand Castings: ASTM B26/B26M.
- F. Aluminum-Alloy Die Castings: ASTM B85/B85M .
- G. Bolts, Nuts, and Washers: Stainless steel.
- H. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.

2.03 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. Continuously seal joined members by intermittent welds and plastic filler.
- D. 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.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.04 PREFABRICATED LADDERS

- A. Prefabricated Ship Ladder: Welded metal unit complying with ANSI A14.3; factory fabricated to greatest degree practical and in the largest components possible.
 - 1. Components: Manufacturer's standard rails, rungs, treads, handrails. returns, platforms and safety devices complying with the requirements of the MATERIALS article of this section.
 - 2. Materials: Aluminum; ASTM B211/B211M 6063 alloy, T52 temper.
 - 3. Incline: 70 to 75 degrees.

4. Finish: Mill finish aluminum.
5. Manufacturers:
 - a. O'Keeffe's Inc; Model 523: www.okeeffes.com/#sle.
 - b. Alaco Ladder; Model H70: www.alacoladder.com.
 - c. Precision Ladders, LLC; Aluminum ships ladder for roof hatches, 70 degree: www.precisionladders.com/#sle.

2.05 FINISHES - STEEL

- A. Prime paint steel items.
 1. Do not prime surfaces in direct contact with concrete.
 2. Do not prime surfaces where field welding is required.
- B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- C. Prime Painting: One coat.
- D. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating.

2.06 FINISHES - ALUMINUM

- A. Interior Aluminum Surfaces: Class I natural anodized or mill finish if available.
- B. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.
- C. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

2.07 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch.
- C. Maximum Misalignment of Adjacent Members: 1/16 inch.
- D. Maximum Bow: 1/8 inch in 48 inches.
- E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 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.

3.03 TOLERANCES

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

END OF SECTION 05 51 33

**SECTION 06 10 00
ROUGH CARPENTRY**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roofing nailers.
- B. Roofing cant strips.
- C. Fire retardant treated wood materials.
- D. Communications and electrical room mounting boards.
- E. Concealed wood blocking, nailers, and supports.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 07 72 00 - Roof Accessories: Prefabricated roof curbs.
- C. Section 09 21 16 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.03 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- C. AWPA U1 - Use Category System: User Specification for Treated Wood; 2023.
- D. PS 1 - Structural Plywood; 2023.
- E. PS 2 - Performance Standard for Wood Structural Panels; 2018.
- F. PS 20 - American Softwood Lumber Standard; 2021.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials and application instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Sizes: Nominal sizes as indicated on drawings, S4S.
- B. Moisture Content: S-dry or MC19.
- C. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

2.03 CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.04 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

2.05 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
- B. Fire Retardant Treatment:
 - 1. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as indicated .
 - c. Do not use treated wood in applications exposed to weather or where the wood may become wet.

PART 3 EXECUTION

3.01 PREPARATION

- A. Coordinate installation of rough carpentry members specified in other sections.

3.02 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top

story and roof/attic space; other material acceptable to authorities having jurisdiction may be used in lieu of solid wood blocking.

- C. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- D. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- E. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.

3.04 INSTALLATION OF CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 3. Install adjacent boards without gaps.

3.05 CLEANING

- A. Waste Disposal: See Section 01 74 19 - Construction Waste Management and Disposal.
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 06 10 00

SECTION 06 41 16
PLASTIC LAMINATE CABINETS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specially fabricated cabinet units.
- B. Countertops.
- C. Cabinet hardware.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 06 10 00 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- C. Section 07 9005 - Sealants
- D. Section 08 80 00 - Glazing: Glass for casework.

1.03 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- B. AWI (QCP) - Quality Certification Program; Current Edition.
- C. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- D. BHMA A156.9 - Cabinet Hardware; 2020.
- E. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- F. WI (CSIP) - Certified Seismic Installation Program (CSIP); Current Edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
 - 2. Allow 4 weeks for Architectural review of shop drawings.
- C. Product Data: Provide data for hardware accessories.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
 - 2. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
- B. Quality Certification:
 - 1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
 - 2. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 3. Provide designated labels on shop drawings as required by certification program.
 - 4. Provide designated labels on installed products as required by certification program.

5. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.
 6. Replace, repair, or rework all work for which certification is refused.
- C. Installation of cabinets shall be the direct responsibility of the manufacturer/Fabricator. The manufacturer/Fabricator may sub-contract the installation subject to approval of installation subcontractor by Architect. Installation shall be accomplished to AWI Section 1700 requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from moisture damage.

1.07 FIELD CONDITIONS

- A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Cohen Architectural Woodworking, LLC 9 Industrial Drive, Saint James, MO 65559; 573.265.7070.
- B. Single Source Responsibility: Provide and install this work from single fabricator.

2.02 CABINETS

- A. Quality Standard: Premium/Custom, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Plastic Laminate Faced Cabinets: Custom Grade Standard
1. Exposed Surfaces: 3/4" INDUSTRIAL GRADE PARTICLE BOARD CORE WITH VERTICAL GRADE PLASTIC LAMINATE (0.028 INCH) ON EXPOSED SIDE WITH WHITE CABINET LINER (0.028 INCH) FUSED TO INTERIOR SIDE. 3MM PVC EDGE BANDING, FINISH AS SCHEDULED, WILL BE APPLIED TO EDGES.
 2. Semi-Exposed Surfaces: 3/4 INCH THICK WHITE TWO SIDED MELAMINE EXCEPT IN TRASH AND LINEN CABINET.
- C. Cabinets:
1. Finish - Exposed Exterior Surfaces: Decorative laminate.
 2. Finish - Exposed Interior Surfaces: Decorative laminate.
 3. Finish - Interior Surfaces: White Melamine.
 4. Finish - Semi-Exposed Surfaces: White Melamine
 5. Finish - Concealed Surfaces: White Melamine
 6. Door and Drawer Front Edge Profiles: Square edge with thick applied band.
 7. Door and Drawer Front Retention Profiles: Fixed panel.
 8. Casework Construction Type: Type A - Frameless.
 9. Grained Face Layout for Cabinet and Door Fronts: Style and Rail, all Grades.
 - a. Doors: Vertical grain.
 10. Grained Face Layout for Cabinet and Door Fronts: Flush panel.
 - a. Custom Grade: Doors, drawer fronts and false fronts wood grain to run and match vertically within each cabinet unit.
 11. Adjustable Shelf Loading: 50 lbs. per sq. ft.
 - a. Deflection: L/240 max.
 12. Cabinet Style: Flush overlay.
 13. Cabinet Doors and Drawer Fronts: Flush style.
 14. Drawer Side Construction: As recommended by fabricator.
 15. Drawer Construction Technique: As recommended by fabricator.

2.03 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.

2.04 LAMINATE MATERIALS

- A. Manufacturers:
 - 1. Formica Corporation: www.formica.com/#sle.
 - 2. Wilsonart LLC: www.wilsonart.com/#sle.
 - 3. Reference Finish Legend for manufacturers and colors.
- B. Provide specific types as indicated.
 - 1. Horizontal Surfaces: (PL) HGS, 0.048 inch nominal thickness, finish as indicated on the drawings
 - 2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, finish as indicated on the drawings.
 - 3. Cabinet Liner: CLS, 0.020 inch nominal thickness, White Melamine.

2.05 COUNTERTOPS

- A. Substrate:
 - 1. Marine grade plywood or Medex substrate required for countertops with a sink.
- B. Solid Surface materials:
 - 1. Manufacturers:
 - a. Wilsonart LLC: www.wilsonart.com/#sle.
 - b. Corian; www.corian.com
 - 2. Fabrication:
 - a. Countertops, Transaction tops, and Wall caps: 1/2" solid surface material with finished edges built up to 1 1/2". 15/16" white one-sided melamine medium density fiberboard build up will be applied in Cohen Architectural Woodworking LLC Plant.
 - b. Build up exposed edges will be banded with white PVC.
 - c. Shelves: 1/2" solid surface material with finished edges built up to 1 1/2". No build down required.
 - d. Window Sills: 1/2" solid surface material with finished edges built up to 2".
 - e. Splash:
 - 1) Integral splash at hospital locations: 1 by 4 inches, unless noted otherwise, solid surface material.
 - 2) Loose splash at clinic locations: 1/2 by 4 inches, unless noted otherwise, solid surface material.
 - f. Exposed edges will be 1/8" roundover top, bottom, and vertical, unless noted otherwise.
 - g. Exposed outside vertical edges > 2 inches will be 1/4 inch roundover.
 - h. Exposed finish will be a matte finish.
 - i. Integral solid surface sinks will be installed in Cohen Architectural Woodworking, LLC plant. Cutouts for sinks (by others) and faucets (by others) will be done in Cohen Architectural Woodworking, LLC plant if approved plumbing specifications are provided prior to fabrication, otherwise they are to be located in field by installer/GC.
 - j. Integral Sink: Gemstone 1812-UVO-ADA. Polar White.
 - k. Outside Corners are 2 inch radius except adjacent to equipment (by others) or noted otherwise.
 - l. Countertops to overhang cabinet end by 1" when outside corner is radiused.
 - m. Countertops to overhang 1/4" when finished end is adjacent to equipment (by others).
 - n. Ends of countertops that butt into a wall (by others) will have an 1/8" added to length of countertop (per unfinished end) for Scribe. Installer/GC to scribe in field.
 - o. Ship the following:

- 1) Glue to match color for field seams (90 LF per 470ml tube or 48 LF per 250ml tube)
 - 2) Sandpaper Kit for field seams (same type of sandpaper used on teh tops so finish will match)
 - 3) Caulk to match color for splash to counter (90 LF per 10oz tube).
3. Reference Finish Legend and Finish Schedule in the drawings for Specific Pattern / color selections and locations.

2.06 TACKBOARDS

- A. Fabric wrapped 3/4" micore 300 core tackable panel wrapped with fabric.
- B. Reference Finish Legend in drawings for specific pattern and color of fabric.
- C. Adhere directional fabric pattern in same orientation on all tackboards.

2.07 FABRIC WRAPPED BENCH

- A. 3/4" ventilated plywood with high resilience 18050 foam wrapped with fabric for bottom cushion, and 3/4" vented plywood with high resilience 18035 foam wrapped with fabric for back cushion.
- B. Reference Finish Legend in drawings for specific pattern and color of fabric.

2.08 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. Nurse station toe kick:
 1. 4" Chemetal, Natural brushed aluminum 791.
- C. Fasteners: Size and type to suit application.
- D. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- E. Concealed Joint Fasteners: Threaded steel.
- F. Grommets: h9.1 60mm GROMMET
 1. Manufacturer: www.hardwareresources.com
 2. Item number: 69000WH
 3. Finish: White
 4. Coordinate exact location with owner for in-field installation.
- G. Brush Grommet Extrusion
 1. Manufacturer: www.mockett.com
 2. Item Number: BREXT
 3. Finish: Light Gray (92)
- H. Decorative trim on Patient Headwall:
 1. Flannery Trim; www.flannerytrim.com
 2. Item number: PCS75-100, EXP 75-100
 3. Finish: Clear Anodized Aluminum
- I. Wardrobe hook
 1. Manufacturer: www.hardwareresources.com
 2. Item number: RH03-PC
 3. Finish: Polished Chrome

2.09 HARDWARE

- A. Adjustable Shelf Supports: Spoon Shelf Support
 1. Manufacturer: www.hardwareresources.com
 2. Item number: 1306BN

- 3. Finish: Bright Nickel
- B. L Shaped Shelf Support: 5mm
 - 1. Manufacturer: www.usfutaba.com
 - 2. Item Number: 72511 52 069
 - 3. Finish: Nickel
- C. Undercounter support brackets: Standard bracket, Hybrid bracket, Concealed bracket
 - 1. Reference elevations or type of bracket needed
 - 2. Manufacturer: www.aandmhardware.com
 - 3. Item numbers: Standard bracket, HYB(1.0) Bracket, (2.0) Concealed Bracket
 - 4. Finish: White 933-58
 - 5. Max spacing 36".
- D. Drawer and Door Pulls: 96mm Pull
 - 1. Manufacturer: www.berensonhardware.com
 - 2. Item number: 9418-4BPN-P
 - 3. Finish: Brushed Nickel
- E. Double Door Latch
 - 1. Manufacturer: www.compx.com
 - 2. Item Number: DL-200-W (Top Mount Kit), DL-300-W (Bottom Mount Kit)
 - 3. Finish: White
 - 4. Add-on to pair door cabinets with lock
- F. Cabinet Locks: CompX Timberline Lock
 - 1. Manufacturer: www.compx.com
 - 2. Item number: C100LP-14A (Lock Plug), CB-185 (Cylinder Body), C100BZ-14A (Bezel), C100SP-19 (Strike Plate)
 - 3. Finish: Polished Nickel
 - 4. Add on option: .Lc Lock keying to be keyed alike: Key #110T
- G. Cabinet Locks: CompX Regulator Lock
 - 1. Manufacturer: www.compx.com
 - 2. Item number: REG-S-x-3
- H. Drawer Slides: Blum Metabox 320 Drawer
 - 1. Manufacturer: www.blum.com
 - 2. Item Number: Metabox 320 Series
 - 3. Finish: White
- I. Drawer Divider:
 - 1. Manufacturer: www.lifestylesystems.com
 - 2. Item number: LS 1003-2
 - 3. Finish: White
- J. File Rail:
 - 1. Manufacturer: www.blum.com
 - 2. Item number: ZRM.5500.US
 - 3. Finish: White/Zinc
- K. Z-Clip
 - 1. Manufacturer: www.monarchmetal.com
 - 2. Item number: MF375
- L. Ball Catch
 - 1. Manufacturer: www.hardwareresources.com
 - 2. Item number: FFC11BLK (False front clip) FFS11 (False front spacer)

- M. 107 degree Hinges:
 - 1. Manufacturer: www.blum.com
 - 2. Item number: 75T1580
 - 3. Finish: Nickel-plated
- N. 170 degree Hinges:
 - 1. Manufacturer: www.blum.com
 - 2. Item number: 71T6580
 - 3. Finish: Nickel-Plated
- O. Restrictor Clip:
 - 1. Manufacturer: www.blum.com
 - 2. Item number: BL-74.1103
 - 3. Finish: Black
 - 4. Add on to 107 degree hinges to restrict opening to 95 degrees.
- P. Hinge Restrictor Bumper:
 - 1. Manufacturer: www.bumperspecialties.com
 - 2. Item number: BS-02
 - 3. Finish: Clear
 - 4. Add on to doors with restrictor clip to restrict opening to 90 degrees.

2.10 FABRICATION CABINETRY UNITS

- A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
 - 1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
 - 2. Cap exposed plastic laminate finish edges with material of same finish and pattern.
- E. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.
- F. Fabricate casework to dimensions, profiles, and details shown.
- G. Utilize PVA glue system for all laminates and melamines, except at countertops where contact adhesive shall be used.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- C. Use fixture attachments in concealed locations for wall mounted components.
- D. Use concealed joint fasteners to align and secure adjoining cabinet units.

- E. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
- F. Caulk all edges of cabinets and countertops to the walls with clear caulking.
- G. Secure cabinets to floor using appropriate angles and anchorages.

3.03 ADJUSTING

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

3.04 CLEANING

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

END OF SECTION 06 41 16

**SECTION 07 62 00
SHEET METAL FLASHING AND TRIM**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings.
- B. Sealants for joints within sheet metal fabrications.

1.02 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- E. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- F. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
- G. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- H. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2018).
- I. CDA A4050 - Copper in Architecture - Handbook; current edition.
- J. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.04 QUALITY ASSURANCE

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

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- C. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sheet Metal Flashing and Trim:
 - 1. Petersen Aluminum Corporation: www.pac-clad.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal.
- B. Pre-Finished Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 18 gauge, 0.040 inch thick; plain finish shop pre-coated with silicone modified polyester coating.
 - 1. Polyvinylidene Fluoride (PVDF) Coating: Superior performing organic powder coating, AAMA 2605; pretreated metal with two-coat system including primer and color coat with at least 70 percent PVDF coating.
- C. Stainless Steel: ASTM A666/A666M, Type 304 alloy, soft temper, 28 gauge, 0.0156 inch thick; smooth No. 4 - Brushed finish.

2.03 FABRICATION

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

2.04 FLASHING

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

2.05 ACCESSORIES

- A. Fasteners: Galvanized steel.
- B. Underlayment: Polyethylene, 6 mil, 0.006 inch thick.
- C. Slip Sheet: Rosin-sized sheathing paper.
- D. Primer Type: Zinc chromate.
- E. Concealed Sealants: Non-curing butyl sealant.
- F. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- G. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch.

3.03 INSTALLATION

- A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..

- B. Apply plastic cement compound between metal flashings and felt flashings.
- C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for field inspection requirements.
- B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION 07 62 00

**SECTION 07 72 00
ROOF ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof curbs.
- B. Roof hatches.

1.02 RELATED REQUIREMENTS

1.03 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. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- H. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Maintenance requirements.
- C. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.
 - 1. Submit shop drawings sealed and signed by a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- D. Warranty Documentation:
 - 1. Submit manufacturer warranty.
 - 2. Ensure that forms have been completed in Owner's name and registered with manufacturer.
 - 3. Submit documentation that roof accessories are acceptable to roofing manufacturer, and do not limit the roofing warranty.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store products under cover and elevated above grade.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for _____. Complete forms in Owner's name and register with manufacturer.
- C. Extended Correction Period: Correct defective work within 5-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.01 ROOF CURBS

- A. Roof Curbs Manufacturers:
 - 1. AES Industries Inc: www.aescurb.com/#sle.
 - 2. The Pate Company: www.patecurbs.com/#sle.
 - 3. LMCurbs; Roof Curbs: www.lmcuibs.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.
 - 1. Applications: Roof curbs used for roof penetrations/openings as indicated on drawings.
 - 2. Roof Curb Mounting Substrate: Curb substrate consists of level, corrugated metal deck..
 - 3. Sheet Metal Material:
 - a. Galvanized Steel: Hot-dip zinc coated steel sheet complying with ASTM A653/A653M, SS Grade 33; G60 coating designation; 18 gauge, 0.048 inch thick.
 - 4. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing system at 1:1 slope; minimum cant height 4 inches.
 - 5. Provide layouts and configurations indicated on drawings.
- C. Curbs Adjacent to Roof Openings: Provide curb on each side of opening, with top of curb horizontal for equipment mounting.
 - 1. Provide preservative treated wood nailers along top of curb.
 - 2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
 - 3. Height Above Finished Roof Surface: 8 inches, minimum.

2.02 ROOF HATCHES

- A. Roof Hatch Manufacturers:
 - 1. Basis of Design: Bilco Company; Type NB (ship stair size): www.bilco.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Roof Hatches : Factory-assembled galvanized steel frame and cover, complete with operating and release hardware.
 - 1. Style: Provide flat metal covers unless otherwise indicated.
 - 2. Mounting Substrate: Provide frames and curbs suitable for mounting on flat roof deck sheathing with insulation.
 - 3. Thermally Broken Hatches: Provide insulation within frame and cover.
 - 4. For Ships Ladder Access: Single leaf; 30 by 54 inches.
- C. Safety Railing System: Roof hatch safety rail system mounted directly to curb without penetration of roofing system.
 - 1. Railing Size: 30 by 54 inches.
 - 2. Railing: Comply with 29 CFR 1910.23 for ladder safety, with a safety factor of two.
 - 3. Self-Closing Gate: Comply with 29 CFR 1910.29 for safe egress and fall protection through hatch opening.

4. Posts and Rails: Galvanized steel tubing.
 5. Gate: Same material as railing; automatic closing with latch.
 6. Finish: Manufacturer's standard, factory applied finish.
 7. Gate Hinges and Post Guides: ASTM B221 (ASTM B221M), 6063 alloy, T5 temper aluminum.
 8. Mounting Brackets: Hot dipped galvanized steel, 1/4 inch thick, minimum.
 9. Fasteners: Stainless steel, Type 316.
 10. Products:
 - a. Basis of Design: BILCO Company: www.bilco.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.
1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf load.
 2. Hinges: Heavy duty pintle type.
 3. Hold open arm with vinyl-coated handle for manual release.
 4. Latch: Upon closing, engage latch automatically and reset manual release.
 5. Manual Release: Pull handle on interior.
 6. Locking: Padlock hasp on interior.

2.03 NON-PENETRATING ROOFTOP SUPPORTS/ASSEMBLIES

- A. Non-Penetrating Rooftop Support/Assemblies: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, and not requiring any attachment to roof structure and not penetrating roofing assembly.
1. Design Loadings and Configurations: As required by applicable codes.
 2. Height: Provide minimum clearance of 6 inches under supported items to top of roofing.
 3. Support Spacing and Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 4. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 5. Hardware, Bolts, Nuts, and Washers: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.
 6. Products:
 - a. Garlock Safety Systems: www.garlocksafety.com/#sle.
 - b. Green Link, Inc: www.greenlinkengineering.com/#sle.
 - c. Metal Roof Innovations, Ltd. S-5! Attachment Solutions: www.s-5.com/#sle.
 - d. PHP Systems/Design: www.phpsd.com/#sle.
- B. Pipe Supports: Provide attachment fixtures complying with MSS SP-58 and as indicated.
1. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
 2. See relevant piping system specification section for additional requirements.
- C. Duct Supports: Provide extruded aluminum supports and sized in accordance with diameter of supported ducts, and with base that is non-penetrating of roofing membrane.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.03 INSTALLATION

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

3.04 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. Clean installed work to like-new condition.

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 07 72 00

**SECTION 07 84 00
FIRESTOPPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 01 70 00 - Execution and Closeout Requirements: Cutting and patching.
- C. Section 09 21 16 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.03 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.
- C. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2015 (Reapproved 2019).
- D. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2023a.
- E. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- F. ITS (DIR) - Directory of Listed Products; Current Edition.
- G. FM (AG) - FM Approval Guide; Current Edition.
- H. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).
- I. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.
- J. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.
- K. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
- B. Installer Qualifications: Company specializing in performing the work of this section and:

1.06 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Firestopping Manufacturers:
 - 1. 3M Fire Protection Products: www.3m.com/firestop/#sle.
 - 2. No substitutions will be accepted.

2.02 MATERIALS

- A. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by SCAQMD 1168.
- B. Mold and Mildew Resistance: Provide firestopping materials with mold and mildew resistance rating of zero(0) in accordance with ASTM G21.
- C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use a system manufactured by 3M that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
- B. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system as manufactured by 3M that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
- C. Through Penetration Firestopping: Use system as manufactured by 3M that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

2.04 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
 - 1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

- B. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- C. Install labeling required by code.

3.04 FIELD QUALITY CONTROL

- A. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 07 84 00

**SECTION 07 92 00
JOINT SEALANTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Self-leveling pourable joint sealants.
- C. Joint backings and accessories.
- D. Environments where airborne contamination in Healthcare USP 800 Rooms
- E. Base Cove sealant

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions: Additional requirements for sealants and primers.
- B. Section 09 21 16 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.
- C. Section 09 30 00 - Tiling: Sealant between tile and plumbing fixtures and at junctions with other materials and changes in plane.

1.03 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015 (Reapproved 2022).
- B. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants; 2018 (Reapproved 2022).
- C. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).
- D. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2022.
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- F. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2023.
- G. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).
- H. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2023.
- I. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Backing material recommended by sealant manufacturer.
 - 4. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 5. Substrates the product should not be used on.
 - 6. Substrates for which laboratory adhesion and/or compatibility testing is required.
 - 7. Certification by manufacturer indicating that product complies with specification requirements.

- C. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
- D. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.
- E. Installer's qualification statement.
- F. Executed warranty.

1.05 QUALITY ASSURANCE

- A. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
 - 1. Adhesion Testing: In accordance with ASTM C794.
 - 2. Compatibility Testing: In accordance with ASTM C1087.
 - 3. Allow sufficient time for testing to avoid delaying the work.
 - 4. Deliver sufficient samples to manufacturer for testing.
 - 5. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.
 - 6. Testing is not required if sealant manufacturer provides data showing previous testing, not older than 24 months, that shows satisfactory adhesion, lack of staining, and compatibility.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nonsag Sealants:
 - 1. Adfast USA Inc: www.adfastcorp.com/#sle.
 - 2. Dow: www.dow.com/#sle.
 - 3. **ChemLink a Soprema Company: www.chemlink.com- 800-826-1681**
 - 4. Pecora Corporation: www.pecora.com/#sle.
 - 5. Sika Corporation: www.usa.sika.com/#sle.
 - 6. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.

2.02 JOINT SEALANT APPLICATIONS

- A. Scope:
 - 1. Exterior Joints:
 - a. Seal open joints except open joints indicated on drawings as not sealed.
 - b. Seal the following joints:
 - 1) Joints between different exposed materials.
 - 2. Interior Joints:
 - a. Do not seal gaps and openings in gypsum board and suspended ceilings
 - b. Seal open joints except specific open joints indicated on drawings as not sealed.
 - c. Seal the following joints:
 - 1) Joints between door frames and window frames and adjacent construction.
 - 2) In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, and piping penetrations.
 - 3. Do Not Seal:
 - a. Joints where sealant is specified to be furnished and installed by manufacturer of product to be sealed.

- b. Joints where sealant installation is specified in other sections.
- B. Exterior Joints: Use non-sag non-staining silicone sealant, unless otherwise indicated.
 - 1. Control and Expansion Joints in Concrete Paving: Self-leveling polyurethane "traffic-grade" sealant.
- C. Interior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.
 - 1. Wall and Ceiling Joints in Non-Wet Areas: Acrylic emulsion latex sealant.
 - 2. Wall and Ceiling Joints in Wet Areas: Nonsag polyurethane sealant for continuous liquid immersion.
 - 3. Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white, gray
 - 4. In Sound-Rated Assemblies: Acrylic emulsion latex sealant.
- D. Interior Wet Areas: Bathrooms, restrooms, kitchens, food service areas, and food processing areas; fixtures in wet areas include plumbing fixtures, food service equipment, countertops, cabinets, and other similar items.
- E. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.03 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.

2.04 NONSAG JOINT SEALANTS

- A. Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
 - 2. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
 - 3. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
 - 4. Color: Match adjacent finished surfaces.
 - 5. Color: To be selected by Architect from manufacturer's standard range.
 - 6. Products:
 - a. Adfast USA Inc; Adseal LM 4600 Series: www.adfastcorp.com/#sle.
 - b. Dow; DOWSIL 790 Silicone Building Sealant: www.dow.com/#sle.
 - c. Dow; DOWSIL 795 Silicone Building Sealant: www.dow.com/#sle.
 - d. Pecora Corporation; Pecora 864 NST (Non-Staining Technology): www.pecora.com/#sle.
 - e. Sika Corporation; Sikasil WS-295: www.usa.sika.com/#sle.
 - f. Tremco Commercial Sealants & Waterproofing; Spectrem 2: www.tremcosealants.com/#sle.
 - g. Tremco Commercial Sealants & Waterproofing; Spectrem 3: www.tremcosealants.com/#sle.
- B. Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
 - 2. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
 - 3. Color: Match adjacent finished surfaces.
 - 4. Products:
 - a. Adfast USA Inc; ADSEAL Production 4550 Series: www.adfastcorp.com/#sle.
 - b. Dow; DOWSIL 999-A Building and Glazing Sealant: www.dow.com/#sle.
 - c. Pecora Corporation; Pecora 860: www.pecora.com/#sle.
 - d. Sika Corporation; Sikasil WS-295: www.usa.sika.com/#sle.

- e. Sika Corporation; Sikasil N-Plus US: www.usa.sika.com/#sle.
- C. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
 - 1. Color: White.
 - 2. Products:
 - a. Adfast USA Inc; ADSEAL KB 4800 Series: www.adfastcorp.com/#sle.
- D. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
 - 2. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 - 3. Color: Match adjacent finished surfaces.
 - 4. Products:
 - a. Pecora Corporation; DynaTrol II: www.pecora.com/#sle.
 - b. Sika Corporation; Sikaflex-1a: www.usa.sika.com/#sle.
 - c. Tremco Commercial Sealants & Waterproofing; Dymonic 100: www.tremcosealants.com/#sle.
- E. Polyurethane Sealant for Continuous Water Immersion: ASTM C920, Grade NS, Uses M and A; single or multicomponent; explicitly approved by manufacturer for continuous water immersion; suitable for traffic exposure when recessed below traffic surface.
 - 1. Movement Capability: Plus and minus 35 percent, minimum.
 - 2. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 - 3. Color: Match adjacent finished surfaces.
 - 4. Products:
 - a. Sika Corporation; Sikaflex-1a: www.usa.sika.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 ACCESSORIES

- A. Sealant Backing Materials, General: Materials placed in joint before applying sealants; assists sealant performance and service life by developing optimum sealant profile and preventing three-sided adhesion; type and size recommended by sealant manufacturer for compatibility with sealant, substrate, and application.
- B. Sealant Backing Rod, Closed-Cell Type:
 - 1. Cylindrical flexible sealant backings complying with ASTM C1330 Type C.
 - 2. Size: 25 to 50 percent larger in diameter than joint width.
- C. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- D. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

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

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.
- C. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

END OF SECTION 07 92 00

**SECTION 08 12 13
HOLLOW METAL FRAMES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-fire-rated hollow metal frames for non-hollow metal doors.
- B. Fire-rated hollow metal frames for non-hollow metal doors.

1.02 RELATED REQUIREMENTS

- A. Section 08 30 00 - Clean Room Doors and Windows.
- B. Section 08 71 00 - Door Hardware: Hardware and silencers.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2022.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.
- D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2020.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
- G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- H. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.
- I. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- J. ITS (DIR) - Directory of Listed Products; Current Edition.
- K. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.
- L. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2011.
- M. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2017.
- N. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
- O. UL (DIR) - Online Certifications Directory; Current Edition.
- P. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.
- D. Installer's qualification statement.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in accordance with applicable requirements and in compliance with standards and/or custom guidelines as indicated.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hollow Metal Frames:
 - 1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 2. Curries, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 3. Republic Doors, an Allegion brand: www.republicdoor.com/#sle.
 - 4. Steelcraft, an Allegion brand: www.allegion.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

- A. Hollow Metal Frames: Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of side hinged doors.
- B. Refer to Door and Frame Schedule on drawings for frame sizes, fire ratings, sound ratings, finishing, door hardware to be installed, and other variations, if any.
- C. Door Frame Type: Provide hollow metal door frames with integral casings.
 - 1. Interior Doors: Use frames with integral casings.
- D. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
- E. Accessibility: Comply with ICC A117.1 and ADA Standards.
- F. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior frame that is also indicated as being sound-rated must comply with the requirements specified for exterior frames and for sound-rated frames; where two requirements conflict, comply with the most stringent.
- G. Hardware Preparations, Selections and Locations: Comply with BHMA A156.115, NAAMM HMMA 830, NAAMM HMMA 831 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

2.03 HOLLOW METAL DOOR FRAMES WITH INTEGRAL CASINGS

- A. Interior Door Frames, Non-Fire Rated: Face welded type.
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
- B. Fire-Rated Door Frames: Face welded type.
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.

2. Fire Rating: As indicated on Door and Frame Schedule, tested in accordance with UL 10C or NFPA 252 ("positive pressure fire tests").
3. Provide units listed and labeled by ITS (DIR) or UL (DIR).
 - a. Attach fire rating label to each fire rated unit.
4. Frame Finish: Factory primed and field finished.

2.04 FINISHES

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

2.05 ACCESSORIES

- A. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Install frames in accordance with manufacturer's instructions and related requirements of specified frame standards or custom guidelines indicated.
- B. Install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
- D. Install door hardware as specified in Section 08 71 00.
- E. Touch up damaged factory finishes.

3.03 TOLERANCES

- A. Maximum Diagonal Distortion: 1/16 inch measured with straight edges, crossed corner to corner.

END OF SECTION 08 12 13

**SECTION 08 14 16
FLUSH WOOD DOORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A. Section 08 12 13 - Hollow Metal Frames.
- B. Section 08 71 00 - Door Hardware.
- C. Section 08 80 00 - Glazing.

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- B. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- E. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- F. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
- G. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
- D. Samples: Submit two samples of door veneer, 10 by 10 inches in size illustrating wood grain, stain color, and sheen.
- E. Test Reports: Show compliance with specified requirements for the following:
- F. Installer's qualification statement.
- G. Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Wood Veneer Faced Doors:
 - 1. Masonite Architectural; Aspiro Select Wood Veneer Doors:
www.architectural.masonite.com/#sle. (Amanda Barkema (541.647.3285))

2.02 DOORS AND PANELS

- A. Doors: See drawings for locations and additional requirements.
 - 1. Quality Standard: Custom Grade, Extra Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
 - 1. Provide solid core doors at each location.
 - 2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.

2.03 DOOR AND PANEL CORES

- A. Non-Rated Solid Core and 20 Minute Rated Doors: Type Extra, Heavy Duty Particleboard. plies and faces as indicated.
- B. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

2.04 DOOR FACINGS

- A. Veneer Facing for Transparent Finish: White Maple for all wood doors except match existing wood door color/finish for doors 200A, 212, 300.1, and 300.3A, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.

2.05 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails: Extra Heavy Duty Particleboard Core or SCLC
 - 1. Provide necessary blocking to eliminate throughbolting.
- C. Edge Construction: Section on Edges
 - 1. Vertical Edgebanding: Wood Veneer to provide matching edges
 - 2. Top & Bottom Edges: (For all door types) Clean Edges for top and bottom of door or matching edges to the face of the door
- D. Provide removable/replaceable lock stile.
- E. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- F. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- G. Provide edge clearances in accordance with the quality standard specified.
- H. Provide vision frame or wood bead molding to match face for the lite opening.

2.06 FINISHES - WOOD VENEER DOORS

- A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 - 1. Transparent:
 - a. System - 1, Lacquer, Nitrocellulose.
 - b. Stain: Clear.
 - c. Sheen: Flat.

2.07 ACCESSORIES

- A. Hollow Metal Door Frames: See Section 08 12 13.
- B. Glazed Openings:
 - 1. Heat-Strengthened and Fully Tempered Glass: ASTM C1048.
 - 2. Fire-Protection-Rated Glass: Safety Certification, 16 CFR 1201, Category II.
 - 3. Glazing: Single vision units, 1/4 inch thick glass.
 - 4. Tint: Clear.
- C. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.
- D. Door Hardware: See Section 08 71 00.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
 - 1. Install fire-rated doors in accordance with NFPA 80 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.
- E. Coordinate installation of glazing.

3.03 TOLERANCES

- A. Comply with specified quality standard for fit and clearance tolerances.
- B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

END OF SECTION 08 14 16

**SECTION 08 30 00
CLEAN ROOM DOORS AND WINDOWS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Power operated Single Swinging Stainless Steel Door System and accessories for complete installation. Applies to doors 215, 216, and 217.
- B. Sterile and Non-Sterile Compounding Windows.

1.02 RELATED SECTIONS

- A. Division 26 - Electrical

1.03 SUBMITTALS

- A. Product Data: Completely describing components.
- B. Shop Drawings: Showing details of fabrication, installation and accommodation to connecting work.
- C. Installation Instructions: For door, and accessories.
- D. Operating and Maintenance Data: For door, and accessories.

1.04 QUALITY ASSURANCE

- A. Installer Qualification: Door or window manufacturer, or trained, approved and licensed door or window installer.

PART 2 - PRODUCT

2.01 MANUFACTURERS

- A. Model 225SS power operated Excel Single Swinging Stainless Steel Door System as manufactured by ASI Doors, Inc., Milwaukee, WI.
- B. Terra Universal Biosafe Cleanroom Window.
- C. Substitutions:
 - 1. No substitution will be considered unless written request for approval has been submitted by the bidder and has been received by the architect at least ten (10) days prior to the date for receipt of bids.
 - 2. Each such request shall include the name of the materials for which it is to be substituted and a complete description of the proposed substitute, including drawings, cuts, mockups, performance and test data, a list of projects of similar scope and photographs of existing installations, and any other information necessary for evaluation.

2.02 SINGLE SWINGING STAINLESS STEEL DOORS

- A. Cleanseal Model 225SS power operated Excel Single Swinging Stainless Steel Door System.
 - 1. Door size to fit door opening as shown on architectural drawings.
 - 2. Doors shall be electric power operated, Single Swinging Stainless Steel Door System.
 - 3. Door panel shall be made of 16 gauge type 304, #4 stainless steel. Doors shall have INVISIBLE EDGE SEAMS continuously welded, ground smooth, refinished, and repolished on all four sides and corners of panel. All hardware reinforcements to be minimum 12 gauge steel. Door bevel shall be 1/8" bevel on 2".
 - 4. Door shall have a styrene core laminated to both face skins.
 - 5. Frame shall be 16 gauge, 304 stainless steel with 2" face, mitered in the corners, welded, ground and polished, providing smooth, flush seamless surfaces. Additionally the mitered corners must be continuously welded through the throat (rabbet(s) and stop) eliminating any seams or the appearance of seams.

6. Standard hardware to include: stainless steel butt hinges, applied with stainless steel fasteners; and push / pull handles, constructed of stainless steel on exposed surfaces.
7. Power drive system to be mechanically operated, 110 volt single phase power open and spring close. Operator works as a conventional manual door closer in event of power failure.
8. Door actuation to be provided by two wall mounted handwave/touchless push plates with time delay close.
9. Doors 215, 216, and 217 shall be interlocked.
10. Swing side of door to be protected by a head mounted active reflecting infrared motion sensor device.
11. Gasket at sides, head, and sill to be non-marking.
12. Vision panel will include two 45 degree sloped stainless steel frames connected internally with no exposed fasteners on either side of the door panel. Include factory installed 1/4 inch tempered glass.

2.03 STERILE AND NON-STERILE COMPOUNDING WINDOWS

A. Biosafe Cleanroom Window

1. Window size as shown on architectural drawings.
2. Frame Construction:
 - a. 304 Stainless steel without exposed hardware or crevices.
 - b. Frame provided with rounded corners for easy disinfection.
3. Glazing material:
 - a. 0.5 inch tempered glass.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes your acceptance of conditions as satisfactory.
 1. Verify opening size, dimensions and tolerances.

3.02 PREPARATION

- A. Protect surrounding areas and surfaces to prevent damage during work of this section.

3.03 INSTALLATION

- A. Install the work in accordance with manufacturer instructions.

3.04 WARRANTIES

- A. Two year limited warranty on all components.

3.05 CLEANING

- A. Leave the premises clean and free of residue of work of this section.

END OF SECTION 08 30 00

**SECTION 08 31 00
ACCESS DOORS AND PANELS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Ceiling-mounted access units.

1.02 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- B. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
- C. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- D. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire; 2019.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- C. Shop Drawings: Indicate exact position of each access door and/or panel unit.
- D. Installer's qualification statement.

1.04 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.01 ACCESS DOORS AND PANELS ASSEMBLIES

- A. Ceiling-Mounted Units for USP 797 and 800 Clean Rooms:
 - 1. Location: Rooms 215, 216 and 217.
 - 2. Panel Material: Stainless Steel, 304 or acceptable material for isolation class 7 clean rooms.
 - 3. Size - Other Ceilings: 24 by 24 inches.
 - 4. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.

2.02 CEILING-MOUNTED ACCESS UNITS

- A. Manufacturers:
 - 1. Terra Universal: www.terrauniversal.com
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Ceiling-Mounted Units: Factory-fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush; square and without rack or warp; coordinate requirements with type of installation assembly being used for each unit.
 - 1. Material: Stainless Steel, 304 or material acceptable for isolation class 7 clean rooms.
 - 2. Door Style: Single thickness with rolled or turned in edges.
 - 3. Frames: 16-gauge, 0.0598-inch minimum thickness.
 - 4. Hardware:
 - a. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.
 - b. Latch/Lock: Screw driver slot for quarter turn cam latch.

- c. Gasketing: as required by manufacturer for isolation class 7 clean rooms.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings are correctly sized and located.
- B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

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

3.03 INSTALLATION

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

END OF SECTION 08 31 00

**SECTION 08 33 13
COILING COUNTER DOORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-fire-rated coiling counter doors and operating hardware.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Rough openings.
- B. Section 08 71 00 - Door Hardware: Cylinder cores and keys.
- C. Section 09 21 16 - Gypsum Board Assemblies: Rough openings.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's standard literature showing materials and details of construction and finish. Include data on electrical operation.
- C. Shop Drawings: Indicate rough and actual opening dimensions, anchorage methods, hardware locations, and installation details.
- D. Samples: Two slats, 4 inches long, illustrating shape, color, and finish texture.
- E. Manufacturer's Installation Instructions: Indicate installation sequence and installation, adjustment, and alignment procedures.
- F. Operation and Maintenance Data: Indicate modes of operation, lubrication requirements and frequency, and periodic adjustments required.

1.05 QUALITY ASSURANCE

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

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for counterbalance shaft assembly. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Coiling Counter Doors:
 - 1. Basis of Design: Cookson; Model ESC10: www.cooksondoor.com.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COILING COUNTER DOORS

- A. Coiling Counter Metal Doors, Non-Fire-Rated: Galvanized steel slat curtain.
 - 1. Mounting: Interior face mounted or as indicated on drawings.
 - 2. Nominal Slat Size: See model information for slat size.
 - 3. Slat Profile: Flat.
 - 4. Finish, Galvanized Steel: Factory baked enamel.

5. Color: As selected by Architect from manufacturer's standard range.
6. Guides: Formed track; same material and finish unless otherwise indicated.
7. Hood Enclosure: Manufacturer's standard; primed steel.
8. Manual hand crank lift operation.
9. Locking Devices: Slide bolt on inside.

2.03 COMPONENTS

- A. Metal Curtain Construction: Interlocking, single-thickness slats.
 1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
 2. Curtain Bottom: Fitted with tube to provide reinforcement and positive contact in closed position.
 3. Steel Slats: ASTM A653/A653M galvanized steel sheet, with minimum G90/Z275 coating; minimum thickness 16 gauge, 0.06 inch.
- B. Guide Construction: Continuous, of profile to retain door in place, with mounting brackets of same metal.
- C. Hood Enclosure: Internally reinforced to maintain rigidity and shape.
- D. Lock Hardware:
 1. Cylindrical Locking Mechanism: Latchset lock cylinder, specified in Section 08 71 00.
 2. Slide Bolt: Provide on both-jamb sides, extending into slot in guides.
- E. Roller Shaft Counterbalance: Steel pipe and torsion steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that adjacent construction is suitable for door installation.
- B. Verify that door opening is plumb, header is level, and dimensions are correct.
- C. Notify Architect of any unacceptable conditions or varying dimensions.
- D. Commencement of installation indicates acceptance of substrate and door opening conditions.

3.02 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- C. Securely and rigidly brace components suspended from structure.
- D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

3.03 TOLERANCES

- A. Maintain dimensional tolerances and alignment with adjacent work.
- B. Maximum Variation From Plumb: 1/16 inch.
- C. Maximum Variation From Level: 1/16 inch.
- D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.04 ADJUSTING

- A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

- A. Clean installed components.

- B. Remove labels and visible markings.

END OF SECTION 08 33 13

**SECTION 08 42 29
AUTOMATIC ENTRANCES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged power-operated door assemblies of following types:
 - 1. Sliding type.
- B. Controllers, actuators and safety devices.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 83 - Wiring Connections.
- B. Section 28 10 00 - Access Control: Connection to access control system; access control devices used as actuators.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/BHMA A156.38 - Low Energy Power Operated Sliding and Folding Doors; 2019.
- C. BHMA A156.10 - Power Operated Pedestrian Doors; 2017.
- D. BHMA A156.19 - Power Assist and Low Energy Power Operated Swinging Doors; 2019.
- E. ITS (DIR) - Directory of Listed Products; Current Edition.
- F. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL (DIR) - Online Certifications Directory; Current Edition.
- H. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate layout and dimensions; head, jamb, and sill conditions; elevations; components, anchorage, recesses, materials, and finishes, electrical characteristics and connection requirements.
 - 2. Identify installation tolerances required, assembly conditions, routing of service lines and conduit, and locations of operating components and boxes.
- C. Product Data: Include system components, sizes, features, and finishes.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and manufacturer's hardware and component templates.
- E. Installer's qualification statement.
- F. Maintenance Data: Include manufacturer's parts list and maintenance instructions for each type of hardware and operating component.
- G. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience and approved by manufacturer.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty. Complete forms in Owner's name and register with manufacturer.
- C. Provide two year manufacturer warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sliding Automatic Entrance Door Assemblies:
 - 1. Stanley Access Technologies; Dura-Glide 3000 Sliding: www.stanleyaccess.com/#sle.
 - 2. No substitutions will be allowed.

2.02 POWER OPERATED DOORS

- A. Power Operated Doors: Provide products that comply with NFPA 101 and requirements of authorities having jurisdiction; provide equipment selected for actual door weight and for light pedestrian traffic, unless otherwise indicated.
 - 1. Sliding and Folding Door Operators: In the event of power failure, provide for manual open, close, and break-away operation of door leaves.
 - 2. Packaged Door Assemblies: Provide components by single manufacturer, factory-assembled, including doors, frames, operators, actuators, and safeties.
 - 3. Exterior and Vestibule Doors: Provide equipment suitable for operating temperature range of minus 20 to plus 140 degrees F ambient.
- B. Sliding Doors with Full Power Operators: Comply with BHMA A156.10; safeties required; provide break-away operation unless otherwise indicated; in the event of break-away operation, interrupt power operation.
 - 1. Comply with UL 325; acceptable evidence of compliance includes UL (DIR) or ITS (DIR) listing or test report by testing agency acceptable to authorities having jurisdiction.

2.03 AUTOMATIC ENTRANCE DOOR ASSEMBLIES

- A. Comply with ADA Standards for egress requirements.
- B. Framing Members: Provide manufacturer's standard extruded aluminum framing, reinforced as required to support imposed loads.
 - 1. Nominal Sizes:
 - a. Single Slide and Bi-Parting Sliding Doors: 1-3/4 inch wide by 4-1/2 inch deep.
- C. Door and Sidelight Construction: Heavy duty interlocked extruded aluminum tubular stile and rail sections, through-rod bolted construction with steel corner support at hinge stile of carrier-suspended swinging panels or mechanically fastened corners with welded reinforcing brackets to reduce sag in sliding or breakout mode.
 - 1. Door Thickness: 1-3/4 inch, nominal.
 - 2. Stile Design: Match existing auto sliding door.
 - 3. Top Rail Height: 4 inch, nominal.
 - 4. Bottom Rail Height: 6 inch, nominal.
 - 5. Glazing Stops: Manufacturer's standard snap-on extruded aluminum square stops with preformed resilient glazing gaskets.
 - 6. Glazing Stop Width: Manufacturers standard.
 - 7. Glazing Thickness: 1/4 inch or 1" as noted on the drawings
- D. Sliding Automatic Door: Telescoping multiple leaf and indicated on the drawings. Electric operation, extruded aluminum glazed door, with frame, and operator concealed overhead
 - 1. Operation: Power open, power close operation.
 - 2. Exterior-Side Actuator/Safety: Motion sensor.

3. Interior-Side Actuator/Safety: Motion sensor.
4. Hold Open: Toggle switch at inside head of doors; this is not a fire-rated door.
5. Door and Frame Finish: Superior performance organic coating. Color as noted on the drawings
 - a. Exterior Unit: Superior performance organic coating. Color to match existing exterior automatic sliding door system.
 - b. Interior Unit: Class 1 Natural Anodized.

2.04 CONTROLLERS, ACTUATORS, AND SAFETIES

- A. Controller: Provide microprocessor operated controller for each door.
- B. Comply with BHMA A156.10 for actuator and safety types and zones.
- C. Proximity Detector Actuator/Safety: Microwave; distance of control sensitivity adjustable.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work and dimensions are as indicated on shop drawings.
- B. Verify that electric power is available, at the correct location, and is of the correct characteristics.

3.02 INSTALLATION

- A. Install equipment in accordance with manufacturer's written instructions, except where more stringent requirements are specified.
- B. Install entrances securely anchored in place, plumb, level, and true to location, in alignment with established lines and grades, without warp, bow, or racking of members.
- C. Where frames are assembled in field, fit frame joints hairline tight without burrs or distortion; rigidly secure nonmoving joints and seal watertight.
- D. Provide for thermal expansion and contraction of door and frame units and live and dead loads that may be transmitted to operating equipment.
- E. Provide for dimensional distortion of components during operation.
- F. Coordinate installation of components with related and adjacent work; level and plumb.

3.03 ADJUSTING

- A. Adjust entrances for correct function and smooth operation, without binding or scraping and without excessive noise; lubricate operating hardware and other moving parts.

3.04 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. Remove temporary protection; clean exposed surfaces.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 79 00 - Demonstration and Training for additional requirements.
- B. Demonstrate operation, operating components, adjustment features, and lubrication requirements.

END OF SECTION 08 42 29

SECTION 08 43 13
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Thermally broken Aluminum-framed storefront, with vision glass [exterior use only]
- B. Non-thermally broken Aluminum-framed storefront, with vision glass [interior use only]

1.02 RELATED REQUIREMENTS

- A. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.
- B. Section 08 42 29 - Automatic Entrances.
- C. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.
- B. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.
- C. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.
- D. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.
- E. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- F. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- G. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- H. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- I. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- J. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
- K. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- L. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- M. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.
- N. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).
- O. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- D. Samples: Submit one sample 12 by 12 inches in size illustrating finished aluminum surface, glass, glazing materials.
- E. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- F. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.
- G. Installer's qualification statement.
- H. Specimen warranty.

1.06 QUALITY ASSURANCE

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

1.07 DELIVERY, STORAGE, AND HANDLING

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

1.08 FIELD CONDITIONS

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

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Aluminum-Framed Storefronts:
 - 1. Kawneer North America: www.kawneer.com/#sle.
 - 2. Oldcastle BuildingEnvelope: www.oldcastlebe.com/#sle.
 - 3. Tubelite, Inc: www.tubeliteinc.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 BASIS OF DESIGN -- FRAMING FOR INSULATING GLAZING

- A. Front-Set Style, Thermally-Broken:

1. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.

2.03 BASIS OF DESIGN -- FRAMING FOR MONOLITHIC GLAZING

A. Front-Set Style:

1. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.

2.04 ALUMINUM-FRAMED STOREFRONT

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.

1. Glazing Rabbet: For 1 inch insulating, non-rated glazing. Glazing rabbet as required by code for monolithic, fire rated glazing.
2. Glazing Position: Front-set.
3. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
4. Finish: Class I natural anodized (interior frames) and High Performance Organic Coatings (exterior frames).
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
5. Finish Color of exterior frames: To match existing adjacent window color.
6. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
7. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
8. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
9. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
10. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
11. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
12. Maintain continuous air barrier and/or vapor retarder seal throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel, and heel bead of glazing compound.
13. Preparation for Window Treatments: Provide reinforced interior horizontal head rail.

B. Performance Requirements

1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Design Wind Loads: Comply with requirements of ASCE 7.
 - b. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
2. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.
3. Condensation Resistance Factor of Framing: 50, minimum, measured in accordance with AAMA 1503.

2.05 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, drainage holes and internal weep drainage system.
 - 1. Framing members for interior applications need not be thermally broken.
 - 2. Framing members for exterior applications must be thermally broken, including door systems.
 - 3. Glazing Stops: Flush.
- B. Glazing: See Section 08 80 00.

2.06 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet Aluminum: ASTM B209/B209M.
- C. Fasteners: Stainless steel.
- D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- E. Glazing Accessories: See Section 08 80 00.

2.07 FINISHES

- A. Interior Frames: Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.
- B. Exterior Frames: High Performance Organic Coating: AAMA 2604; multiple coats, thermally cured fluoropolymer system.
- C. Color of Exterior Frames: To match existing adjacent window color..

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

3.02 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- I. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

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

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for general testing and inspection requirements.

3.05 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.
- C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.06 PROTECTION

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

END OF SECTION 08 43 13

SECTION 087100
DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
1. Swinging doors.
 2. Sliding doors.
 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
1. Mechanical door hardware.
 2. Electromechanical door hardware.
 3. Automatic operators.
 4. Cylinders specified for doors in other sections.
- C. Related Sections:
1. Division 08 Section “Hollow Metal Doors and Frames”.
 2. Division 08 Section “Stainless Steel Doors and Frames”.
 3. Division 08 Section “Flush Wood Doors”.
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 2. ICC/IBC - International Building Code.
 3. NFPA 70 - National Electrical Code.
 4. NFPA 80 - Fire Doors and Windows.
 5. NFPA 101 - Life Safety Code.
 6. NFPA 105 - Installation of Smoke Door Assemblies.
 7. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
 8. State Building Codes, Local Amendments.

HFG Architecture 2026

- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

1.4 CLOSEOUT SUBMITTALS

- A. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.
- B. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01, Project Record Documents.

1.5 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 5 years documented experience installing both standard and electrified door hardware 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.

- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 - 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
 - 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 - 3. Review sequence of operation narratives for each unique access controlled opening.
 - 4. Review and finalize construction schedule and verify availability of materials.
 - 5. Review the required inspecting, testing, commissioning, and demonstration procedures

HFG Architecture 2026

- I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.7 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.8 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Hardware shall not have any visible manufacturer names on exposed materials, except cylinders, when the door is in a closed position.

2.2 BUTT HINGES

- A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for all out-swinging lockable doors.
5. Manufacturers:
 - a. Hager Companies (HA) - BB Series, 5-knuckle.
 - b. McKinney (MK) - TA/T4A Series, 5-knuckle.

2.3 CONTINUOUS HINGES

- A. Continuous Double-Acting Hinges (Behavioral Health). ANSI/BHMA A156.26 Grade 1-300 Certified continuous hinges.

HFG Architecture 2026

1. Provide hinges with functions and features as follows:
 - a. ADA compliance meeting ICC/ANSI A117.1 (2009) for barrier free compliance.
 - b. CMS Compliance eliminating additional ligature points ensuring compliance for reimbursement through Centers for Medicare and Medicaid Services.
 - c. Opens 100° in either direction.
 - d. Built-in stop to prevent finger pinching.
 - e. Spans the entire opening height eliminating hinge side sight lines.
 - f. Provide an emergency release stop to create a complete anti-barricade system with a flush bolt that is used to release the door in emergency situations that allows it to swing in the opposite direction. Stop shall be supplied standard with Torx security screws and hospital tips.
2. Manufacturers:
 - a. Markar Products; ASSA ABLOY Architectural Door Accessories (MR) - DSH1000.
 - b. Pemko (PE) - DSH1000 Series.
 - c. No Substitution.

2.4 POWER TRANSFER DEVICES

- A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:
 - a. Von Duprin (VD) - EPT-10 Series.
 - b. No Substitution.

2.5 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.
 1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
 2. Furnish dust proof strikes for bottom bolts.
 3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
 5. Manufacturers:

- a. Burns Manufacturing (BU).
 - b. Door Controls International (DC).
 - c. Rockwood (RO).
- B. Coordinators: ANSI/BHMA A156.3 door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.
 - 1. Manufacturers:
 - a. Burns Manufacturing (BU).
 - b. Door Controls International (DC).
 - c. Rockwood (RO).

2.6 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
 - 1. Manufacturers:
 - a. Sargent Manufacturing (SA).
 - b. No Substitution.
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
 - 1. Threaded mortise cylinders with rings and cams to suit hardware application.
 - 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
 - 4. Tubular deadlocks and other auxiliary locks.
 - 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 - 6. Keyway: Match Facility Standard.
- C. Keying System: Each type of lock and cylinders to be factory keyed.
 - 1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
 - 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 - 3. Existing System: Field verify and key cylinders to match Owner's existing system.
- D. Key Quantity: Provide the following minimum number of keys:
 - 1. Change Keys per Cylinder: Two (2)
 - 2. Master Keys (per Master Key Level/Group): Five (5).

E. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.7 KEY CONTROL

- A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).
 - c. Telkee (TK).

2.8 MORTISE LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.

1. Electromechanical locksets shall have the following functions and features:
 - a. Universal Molex plug-in connectors that have standardized color-coded wiring and are available in fail safe or fail secure and operate from 12vdc to 24vdc regulated.
 - b. EcoFlex or equivalent technology that reduces energy consumption up to 92% as certified by GreenCircle.
 - c. Motorized electric latch retraction where the latchbolt retracts in 0.5 seconds of power being applied; removing power allows the latch to project back to the extended position. Motorized latch retraction force exceeds ANSI/BHMA 50 lbs. warped door test.
 - d. Options to be available for request-to-exit or enter signaling, latchbolt and deadbolt monitoring.
 - e. Two-year limited warranty on electrified functions.
2. Manufacturers:
 - a. Schlage (SC) - L9000 Series.

2.9 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
 - 4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
 - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 - 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 - 4. Dustproof Strikes: BHMA A156.16.

2.10 SURFACE DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
 - 1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
 - 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 - 3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
 - 4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 - 5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 - 6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

HFG Architecture 2026

1. Manufacturers:
 - a. LCN Closers (LC) - 4040XP Series.
 - b. No Substitution.

2.11 ELECTROHYDRAULIC DOOR OPERATORS

- A. Electrohydraulic Door Operators (High Traffic): Provide ANSI/BHMA A156.19 Certified Products Directory (CPD) listed low energy operators that meet ANSI/BHMA A156.4 requirements and are UL listed for use on fire rated doors and UL10C certified that comply with requirements for the Americans with Disabilities Act (ADA). Operators shall be verified by GreenCircle to offer energy savings of 19% when compared to similar products to accommodate openings up 250 pounds and 48” wide. Provide accessories such as custom templates, special mounting brackets, spacers and drop plates as needed for proper installation. Operators shall accommodate openings up to 200 pounds and 48” wide. Listed manufacturers shall meet all functions and features as specified herein.

1. Provide operators with features as follows:
 - a. Non-handed with push and pull side mounting.
 - b. Operates as mechanical surface closer during close cycles, when door is opened manually or if power is off.
 - c. Activation by push button, hands-free or radio frequency devices.
 - d. On board electronics to collect usage and cycle count data to facilitate preventative maintenance/diagnostics.
 - e. Two-year limited warranty.
 - f. Wi-Fi interface where the operator is a secure, password protected WiFi hot spot with no connection to building’s IT required.
 - 1) Simple setup with no app required.
 - 2) View status and make adjustments without removing the cover.
 - 3) Built-in logic to support single use restroom applications with no external relay boards, logic modules, position switches required.
 - g. Mounting backplate to simplify and speed up installation.
2. Operators shall have the following functionality:
 - a. Adjustable Hold Open: Amount of time a door will stay in the full open position after an activation.
 - b. Blow Open for Smoke Ventilation: Door opens when signal is received from alarm system allowing air or smoke to flow through opening. Door will stay open until signal from alarm system is stopped.
 - c. Infinite Hold Open: Door will hold open at set position until power is turned off.
 - d. Obstruction Detection: Door closes if it hits an obstruction while opening; door will reverse to open position if it hits an obstruction while closing. Door will stop once it hits an obstruction and will rest against the obstruction until removed.
 - e. Open Delay: Delays operator opening for locking hardware.
 - f. Overload Safety Shut-Off: After two minutes of receiving a door activation signal, inverter times out and door closes to prevent motor/inverter damage.

HFG Architecture 2026

- g. Presence Detector Input: Input for external sensor to detect presence at door open or close position only.
 - h. Push & Go: As the door is manually opened, the operator "senses" movement and opens door to the full-open position.
 - i. Selector Mode Switch: Off disables the signal inputs unless Blow Open is activated, on activates the signal inputs, hold open activates the unit (unless Blow Closed is activated) to the hold open position.
 - j. Vestibule Delay: When the wall switch is pressed, first door in vestibule will open. Second door will open once vestibule door delay has expired. Delay is adjustable.
3. Manufacturers:
- a. Norton Rixson (NO) - 6000 Series.

2.12 ARCHITECTURAL TRIM AND ACCESSORIES

A. Door Protective Trim:

- 1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
- 2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
- 3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
- 4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, .050-inch thick.
- 5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
- 6. Manufacturers:
 - a. Burns Manufacturing (BU).
 - b. Hager Companies (HA).
 - c. Hiawatha, Inc. (HI).
 - d. Rockwood (RO).

2.13 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 - 1. Manufacturers:
 - a. Burns Manufacturing (BU).
 - b. Hager Companies (HA).
 - c. Hiawatha, Inc. (HI).
 - d. Rockwood (RO).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
 - 1. Manufacturers:
 - a. Norton Rixson (RF).
 - b. Rockwood (RO).
 - c. Sargent Manufacturing (SA).

2.14 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko (PE).
 - 3. Reese Enterprises, Inc. (RE).

2.15 ELECTRONIC ACCESSORIES

2.16 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.17 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Push Plates and Door Pulls: When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.
- E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- F. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.

1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

- B. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko

HFG Architecture 2026

3. VO - Von Duprin
4. RO - Rockwood
5. SC - Schlage
6. SA - SARGENT
7. RF - Rixson
8. LC - LCN Closers
9. NO - Norton

Hardware Sets

Set: 1.0

Doors: 200A

Description: Intake (Rated)

3 Hinge, Full Mortise	T4A4786 or T4A3786 NRP 5" x 4-1/2"	US26D	MK
1 Electric Power Transfer	EPT10	.689	VO ⚡
1 Electrified Mortise Lock	L9692EU .L .06A .RX .DPS	.626	SC
1 Mortise Cylinder	41 GMK	US32D	SA
1 Automatic Opener	6021	689	NO ⚡
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL (Head & Jambs)		PE
2 Wall Switch	700		NO ⚡
1 Power Supply	PS902		VO ⚡

Notes: Card reader furnished by Owner.

Request to exit and door position switch will be in the mortise lock body.

Operation: Doors are normally closed and locked. When a valid credential is presented to the wall mounted card reader the outside trim on the mortise lock will release and you can turn the lever and enter the space. When the door comes back closed the outside trim will relock. The inside trim will have a REX or request to exit switch built into the lock. The mortise lock body will also have a door position switch built into the lock body. You can always turn the inside lever and exit out of the space.

Set: 2.0

Doors: 203.3

Description: Storage

3 Hinge, Full Mortise	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	L9080 .L .06A	.626	SC
1 Mortise Cylinder	41 GMK	US32D	SA
1 Surface Closer	4040XP .CUSH	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
3 Silencer	608		RO

Set: 3.0

Doors: 204, 205

HFG Architecture 2026

Description: Private Room

3 Hinge, Full Mortise	T4A4786 or T4A3786 5" x 4-1/2"	US26D	MK
1 Push/Pull Mortise Lock	HL6-9010	.626	SC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Door Stop	474	US26D	RO
1 Gasketing	S88BL (Head & Jambs)		PE

Notes: Door stop 474 to be mounted up high so the stop hit with in the top 4" of the door.

Set: 4.0

Doors: 206

Description: Staff Toilet

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Privacy Lock w/ indicator	L9040 .06A .OS-OCC .09-509x.L583-363	.626	SC
1 Surface Closer	4040XP .REGARM	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Wall Stop	406	US32D	RO
1 Gasketing	S773BL (Head & Jambs)		PE

Set: 5.0

Doors: 207

Description: Staff Lounge

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Passage Latch	L9010 .06A	.626	SC
1 Wall Stop	406	US32D	RO
3 Silencer	608		RO

Set: 6.0

Doors: 208

Description: Patient Toilet

1 Cont Hinge, Double Swing	DSH1000 x Door Height		PE
1 Privacy Lock w/ indicator	L9040 .06A .OS-OCC .09-509x.L583-363	.626	SC
1 Conc Overhead Stop	2 Series (Special Template)	652	RF
1 Emergency Stop	ERSBH84C		PE

Set: 7.0

Doors: 209

Description: Oxygen (Rated)

6 Hinge, Full Mortise	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Flush Bolt w/Fire Bolt	2948	US32D	RO
1 Storeroom Lock	L9080 .L .06A	.626	SC
1 Mortise Cylinder	41 GMK	US32D	SA

HFG Architecture 2026

1 Coordinator	1700	Black	RO
2 Surface Closer	4040XP .EDA	.689	LC
2 Kick Plate	K1050 10" x 1" LDW CSK BEV	US32D	RO
2 Wall Stop	406	US32D	RO
2 Astragal	18041CNB x Door Height		PE
1 Gasketing	S88BL (Head & Jambs)		PE

Set: 8.0

Doors: 210, 220

Description: Med Prep, Clean Supply

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Electric Power Transfer	EPT10	.689	VO ⚡
1 Electrified Mortise Lock	L9092EU .L .06A .RX .DPS	.626	SC ⚡
1 Mortise Cylinder	41 GMK	US32D	SA
1 Surface Closer	4040XP .REGARM	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608		RO
1 Power Supply	PS902		VO ⚡

Notes: Card reader furnished by Owner.

Request to exit and door position switch will be in the mortise lock body.

Operation: Doors are normally closed and locked. When a valid credential is presented to the wall mounted card reader the outside trim on the mortise lock will release and you can turn the lever and enter the space. When the door comes back closed the outside trim will relock. The inside trim will have a REX or request to exit switch built into the lock. The mortise lock body will also have a door position switch built into the lock body. You can always turn the inside lever and exit out of the space.

Set: 9.0

Doors: 211

Description: Work Area

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Electric Power Transfer	EPT10	.689	VO ⚡
1 Electrified Mortise Lock	L9092EU .L .06A .RX .DPS	.626	SC ⚡
1 Mortise Cylinder	41 GMK	US32D	SA
1 Surface Closer	4040XP .CUSH	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
3 Silencer	608		RO
1 Power Supply	PS902		VO ⚡

Notes: Card reader furnished by Owner.

Request to exit and door position switch will be in the mortise lock body.

Operation: Doors are normally closed and locked. When a valid credential is presented to the wall mounted card reader the outside trim on the mortise lock will release and you can turn the lever and enter the space. When the door comes back closed the outside trim will relock. The inside trim will have a REX

or request to exit switch built into the lock. The mortise lock body will also have a door position switch built into the lock body. You can always turn the inside lever and exit out of the space.

Set: 10.0

Doors: [212](#)

Description: Decasing

3 Hinge, Full Mortise	T4A4786 or T4A3786 5" x 4-1/2"	US26D	MK
1 Electric Power Transfer	EPT10	.689	VO ⚡
1 Electrified Mortise Lock	L9092EU .L .06A .RX .DPS	.626	SC ⚡
1 Mortise Cylinder	41 GMK	US32D	SA
1 Surface Closer	4040XP .REGARM	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608		RO
1 Power Supply	PS902		VO ⚡

Notes: Card reader furnished by Owner.

Request to exit and door position switch will be in the mortise lock body.

Operation: Doors are normally closed and locked. When a valid credential is presented to the wall mounted card reader the outside trim on the mortise lock will release and you can turn the lever and enter the space. When the door comes back closed the outside trim will relock. The inside trim will have a REX or request to exit switch built into the lock. The mortise lock body will also have a door position switch built into the lock body. You can always turn the inside lever and exit out of the space.

Set: 11.0

Doors: [214](#)

Description: Storage

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	L9080 .L .06A	.626	SC
1 Mortise Cylinder	41 GMK	US32D	SA
1 Wall Stop	406	US32D	RO
3 Silencer	608		RO

Set: 12.0

Doors: [215](#), [216](#), [217](#)

Description: Ante Room, USP 800, USP 797

3 Hinge, Full Mortise	T4A3386 5" x 4-1/2"	US32D	MK
1 Electric Power Transfer	EPT10	.689	VO ⚡
1 Passage Latch w/MLR	L9510 .06A	.626	SC
1 Automatic Opener	6021	.689	NO ⚡
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Wall Stop	406	US32D	RO
1 Gasketing	S773BL (Head & Jamb)		PE
2 Wall Switch	700		NO ⚡

HFG Architecture 2026

1 Power Supply PS902 VO ⚡

Note: Hardware indicated shall be provided by door manufacturer.

Set: 13.0

Doors: 218, 219

Description: Patient Toilet

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Privacy Lock w/ indicator	L9040 .06A .OS-OCC .09-509x.L583-363	.626	SC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Wall Stop	406	US32D	RO
1 Gasketing	S773BL (Head & Jambs)		PE

Set: 14.0

Doors: 222

Description: Soiled Holding (Rated)

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	L9080 .L .06A	.626	SC
1 Mortise Cylinder	41 GMK	US32D	SA
1 Surface Closer	4040XP .REGARM	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL (Head & Jambs)		PE

Set: 15.0

Doors: 223

Description: Shared Office (Rated)

3 Hinge, Full Mortise	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Electric Power Transfer	EPT10	.689	VO ⚡
1 Electrified Mortise Lock	L9092EU .L .06A .RX .DPS	.626	SC ⚡
1 Mortise Cylinder	41 GMK	US32D	SA
1 Surface Closer	4040XP .EDA	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL (Head & Jambs)		PE
1 Power Supply	PS902		VO ⚡

Notes: Card reader furnished by Owner.

Request to exit and door position switch will be in the mortise lock body.

Operation: Doors are normally closed and locked. When a valid credential is presented to the wall mounted card reader the outside trim on the mortise lock will release and you can turn the lever and enter the space. When the door comes back closed the outside trim will relock. The inside trim will have a REX or request to exit switch built into the lock. The mortise lock body will also have a door position switch built into the lock body. You can always turn the inside lever and exit out of the space.

HFG Architecture 2026

Set: 16.0

Doors: 224

Description: Office

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Entrance/Office	L9050 .L .06A	.626	SC
1 Mortise Cylinder	41 GMK	US32D	SA
1 Wall Stop	406	US32D	RO
3 Silencer	608		RO

Set: 17.0

Doors: 225

Description: Consult (Rated)

3 Hinge, Full Mortise	T4A4786 or T4A3786 5" x 4-1/2"	US26D	MK
1 Passage Latch	L9010 .06A	.626	SC
1 Surface Closer	4040XP .REGARM	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Gasketing	S88BL (Head & Jambs)		PE

Set: 18.0

Doors: 227

Description: Blood Draw (Rated)

3 Hinge, Full Mortise	T4A4786 or T4A3786 5" x 4-1/2"	US26D	MK
1 Electric Power Transfer	EPT10	.689	VO ⚡
1 Electrified Mortise Lock	L9092EU .L .06A .RX .DPS	.626	SC ⚡
1 Mortise Cylinder	41 GMK	US32D	SA
1 Surface Closer	4040XP .REGARM	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL (Head & Jambs)		PE
1 Power Supply	PS902		VO ⚡

Notes: Card reader furnished by Owner.

Request to exit and door position switch will be in the mortise lock body.

Operation: Doors are normally closed and locked. When a valid credential is presented to the wall mounted card reader the outside trim on the mortise lock will release and you can turn the lever and enter the space. When the door comes back closed the outside trim will relock. The inside trim will have a REX or request to exit switch built into the lock. The mortise lock body will also have a door position switch built into the lock body. You can always turn the inside lever and exit out of the space.

Set: 19.0

Doors: 211A

Description: Work Area

Notes: All hardware furnished by the Coiling Door Supplier.

Set: 20.0

Doors: 300.1

Description: EVS (Rated)

3 Hinge, Full Mortise	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	L9080 .L .06A	.626	SC
1 Mortise Cylinder	41 GMK	US32D	SA
1 Surface Closer	4040XP .CUSH	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Gasketing	S88BL (Head & Jambs)		PE

Set: 21.0

Doors: 300.3A

Description: MTS

3 Hinge, Full Mortise	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Electric Power Transfer	EPT10	.689	VO ⚡
1 Electrified Mortise Lock	L9092EU .L .06A .RX .DPS	.626	SC ⚡
1 Mortise Cylinder	41 GMK	US32D	SA
1 Surface Closer	4040XP .CUSH	.689	LC
1 Kick Plate	K1050 10" x 2" LDW CSK BEV	US32D	RO
1 Gasketing	S88BL (Head & Jambs)		PE
1 Power Supply	PS902		VO ⚡

Notes: Card reader furnished by Owner.

Request to exit and door position switch will be in the mortise lock body.

Operation: Doors are normally closed and locked. When a valid credential is presented to the wall mounted card reader the outside trim on the mortise lock will release and you can turn the lever and enter the space. When the door comes back closed the outside trim will relock. The inside trim will have a REX or request to exit switch built into the lock. The mortise lock body will also have a door position switch built into the lock body. You can always turn the inside lever and exit out of the space.

Set: 22.0

Doors: 405A, 405B

Description: Room

Notes: All hardware furnished by Door Supplier.

END OF SECTION

**SECTION 08 80 00
GLAZING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Insulating glass units.
- B. Fire rated glazing units.
- C. Sheet Glass units.
- D. Glazing compounds.

1.02 RELATED REQUIREMENTS

- A. Section 07 92 00 - Joint Sealants: Sealants for other than glazing purposes.
- B. Section 08 14 16 - Flush Wood Doors: Glazed lites in doors.
- C. Section 08 42 29 - Automatic Entrances: Glazing provided as part of door assembly.
- D. Section 08 43 13 - Aluminum-Framed Storefronts: Glazing provided as part of storefront assembly.

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- D. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2019).
- E. ASTM C1036 - Standard Specification for Flat Glass; 2021.
- F. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
- G. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.
- H. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2016.
- I. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.
- J. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. ITS (DIR) - Directory of Listed Products; Current Edition.
- L. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- M. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.
- N. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2023.
- O. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2023.
- P. UL (DIR) - Online Certifications Directory; Current Edition.
- Q. UL 9 - Standard for Fire Tests of Window Assemblies; Current Edition, Including All Revisions.
- R. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

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

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data on Insulating Glass Unit, Glazing Unit, and Fire Rated Glazing Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Samples: Submit two samples 10 by 10 inch in size of glass units.
- E. Certificate: Certify that products of this section meet or exceed specified requirements.
- F. Installer's qualification statement.
- G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Fire rated glass and framing must be provided by a single-source, US manufacturer.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

1.06 FIELD CONDITIONS

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

1.07 WARRANTY

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Glass Fabricators:
 - 1. GGI - General Glass International: www.generalglass.com/#sle.
 - 2. Standard Bent Glass Corp: www.standardbent.com/#sle.
 - 3. Tecnoglass; Insulating Glass: www.tecnoglass.com/#sle.
 - 4. Thompson I.G., LLC: www.thompsonig.com/#sle.
 - 5. Trulite Glass & Aluminum Solutions, LLC: www.trulite.com/#sle.
 - 6. Viracon, Inc: www.viracon.com/#sle.
 - 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Float Glass Manufacturers:
 - 1. AGC Glass North America, Inc: www.agcglass.com/#sle.
 - 2. Cardinal Glass Industries: www.cardinalcorp.com/#sle.

3. Guardian Glass, LLC: www.guardianglass.com/#sle.
 4. Pilkington North America Inc: www.pilkington.com/na/#sle.
 5. Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com/#sle.
 6. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- C. Fire-Protection-Rated Glass: Provide products as required to achieve indicated fire-rating period.
1. Manufacturers:
 - a. SAFTIFIRST, a division of O'Keeffe's Inc; SuperClear 45-HS: www.safti.com/#sle.
 2. Substitutions: See Section 01 60 00 - Product Requirements.
 3. Properties:
 - a. Individual Lites shall be permanently identified with a listing mark.

2.02 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
1. Design Pressure: Calculated in accordance with ASCE 7.
 2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 3. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 4. Glass thicknesses listed are minimum.
- B. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.03 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
 2. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
 3. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
 4. Tinted Type: ASTM C1036, Class 2 - Tinted, Quality - Q3, with color and performance characteristics as indicated.
 5. Thicknesses: As indicated on the drawings; provide greater thickness as required for interior glazing design.

2.04 INSULATING GLASS UNITS

- A. Manufacturers:
1. Glass: Any of the manufacturers specified for float glass.
- B. Fabricator: Certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.
- C. Insulating Glass Units: Types as indicated.
1. Durability: Certified by an independent testing agency to comply with ASTM E2190.

2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass or coated spandrel glass, Kind CS.
3. Spacer Color: Match existing insulated glass spacer.
4. Edge Seal:
 - a. Color: Match existing edge seal..
5. Purge interpane space with dry air, hermetically sealed.
- D. Type GL-2 - Insulating Glass Units: Vision glass, double glazed.
 1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with air.
 3. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
 - a. Tint: Match existing tint.
 - b. Coating: Low-E (passive type), on #2 surface.
 4. Inboard Lite: Annealed float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 5. Total Thickness: 1 inch.
 6. Thermal Transmittance (U-Value): , Match existing..
 7. Visible Light Transmittance (VLT): , Match existing.
 8. Solar Heat Gain Coefficient (SHGC): , Match existing.
 9. Visible Light Reflectance: Match existing.
 10. Glazing Method: Dry glazing method, gasket glazing.
- E. Type GL-1 - Insulating Glass Units: Safety glazing.
 1. Applications:
 - a. Glazed lites in exterior doors.
 - b. Glazed sidelights and panels next to exterior doors.
 - c. Other locations required by applicable federal, state, and local codes and regulations.
 2. Space between lites filled with air.
 3. Glass Type: Same as Type GL-2 except use fully tempered float glass for both outboard and inboard lites.
 4. Same tint and match same characteristics as Type GL-2 glass

2.05 GLAZING UNITS

- A. Type GL-4 - Monolithic Interior Vision Glazing:
 1. Applications: Interior glazing unless otherwise indicated.
 2. Glass Type: Annealed float glass unless noted otherwise.
 3. Tint: Clear.
 4. Thickness: 1/4 inch, nominal.
- B. Type GL-5 - Fire-Protection-Rated Glazing: Type, thickness, and configuration of glazing that contains flame, smoke, and does not block radiant heat, as required to achieve fire-doors indicated fire-rating period of 90 minutes or less.
 1. Applications:
 - a. Glazing in fire-rated door assembly.
 - b. Other locations as indicated on drawings.
 2. Glass Type: Specialty tempered float glass.
 3. Provide products listed by {rs\#2} or {rs\#2} and approved by authorities having jurisdiction.
 4. Safety Glazing Certification: 16 CFR 1201 Category II.
 5. Fire-Rating Period: As indicated on drawings.

6. Markings for Fire-Protection-Rated Glazing Assemblies: Provide permanent markings on fire-protection-rated glazing in compliance with {rs\#1}, local building code, and authorities having jurisdiction
 - a. "D" - meets fire door assembly criteria of NFPA 252, UL 10B, or UL 10C fire test standards.
 - b. "OH" - meets fire window assembly criteria including hose stream test of NFPA 257, or UL 9 fire test standards.
 - c. "H" - meets fire door assembly hose stream test of NFPA 252, UL 10B, or UL 10C fire tests standards.
 - d. "XXX" - placeholder that represents fire-rating period, in minutes.
- C. Type GL-3 - Monolithic Safety Glazing: Non-fire-rated.
 1. Applications:
 - a. Glazed lites in doors, except fire doors.
 - b. Glazed sidelights to doors, except in fire-rated walls and partitions.
 - c. Other locations required by applicable federal, state, and local codes and regulations.
 - d. Other locations indicated on drawings.
 2. Glass Type: Fully tempered safety glass as specified.
 3. Tint: Clear.
 4. Thickness: 1/4 inch, nominal.

2.06 ACCESSORIES

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.
- B. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.
- C. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.
- D. Glazing Clips: Manufacturer's standard type.

2.07 SOURCE QUALITY CONTROL

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

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

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

3.02 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.

3.04 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

- A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.
- B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.05 INSTALLATION - DRY GLAZING METHOD (TAPE AND TAPE)

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

3.06 INSTALLATION OF FIRE RATED GLAZING

- A. Materials and methods for installing fire rated glazing shall conform to manufacturer's tested and approved assemblies.

3.07 INSTALLATION - WET GLAZING METHOD (COMPOUND AND COMPOUND)

- A. Application - Interior Glazed: Set glazing infills from the interior of the building.
- B. Install glazing resting on setting blocks. Install applied stop and center pane by use of spacer shims at 24 inch centers, kept 1/4 inch below sight line.
- C. Locate and secure glazing pane using glazers' clips.
- D. Fill gaps between glazing and stops with glazing compound until flush with sight line. Tool surface to straight line.

3.08 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove nonpermanent labels immediately after glazing installation is complete.
- C. Clean glass and adjacent surfaces after sealants are fully cured.
- D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.09 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.

- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION 08 80 00

**SECTION 08 87 23
SAFETY AND SECURITY FILMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glazing film applied to new glazing assemblies.
- B. Glazing film applied to a portion of glazing at doors 200A and 225. See drawing sheet A-601 - Door Information.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Infinite Optiks; <https://infiniteoptics.com/>

2.02 SAFETY AND SECURITY GLAZING FILM

2.03 MATERIALS

- A. Glazing Film: Translucent embossed vinyl film
 - 1. Thickness: 7mm
 - 2. Color: Clear Sand Blast
 - 3. Adhesive Type: Pressure sensitive

PART 3 EXECUTION

3.01 EXAMINATION

- A. Field -Applied Film: Verify that existing conditions are adequate for proper application and performance of film.
- B. Examine glass and frames. Verify that existing conditions are adequate for proper application and performance of film.
- C. Verify glass is not cracked, chipped, broken, or damaged.
- D. Verify that frames are securely anchored and free of defects.
- E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean glass of dust, dirt, paint, oil, grease, mildew, mold, and other contaminants that would inhibit adhesion.
- B. Immediately prior to applying film, thoroughly wash glass with neutral cleaning solution.
- C. Protect adjacent surfaces.
- D. Do not begin installation until substrates have been properly prepared.

3.03 INSTALLATION

- A. Do not apply glazing film when surface temperature is less than 40 degrees F or if precipitation is imminent.
- B. Install in accordance with manufacturer's instructions, without air bubbles, wrinkles, streaks, bands, thin spots, pinholes, or gaps, as required to achieve specified performance.
- C. Accurately cut film with straight edges to required sizes allowing 1/16 inch to 1/8 inch gap at perimeter of glazed panel unless otherwise required by anchorage method.
- D. Seams: Seam film only as required to accommodate material sizes; form seams vertically without overlaps and gaps; do not install with horizontal seams.

- E. Clean glass and anchoring accessories following installation. Remove excess sealants and other glazing materials from adjacent finished surfaces.
- F. Remove labels and protective covers.

3.04 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 08 87 23

SECTION 09 05 61
COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
 - 1. Resilient sheet.
 - 2. Carpet tile.
 - 3. Thin-set ceramic tile and stone tile.
- B. Preparation of new and existing concrete floor slabs for installation of floor coverings.
- C. Testing of concrete floor slabs for moisture and alkalinity (pH).
- D. Patching compound.
- E. Remedial floor coatings.
- F. Remedial floor sheet membrane.

1.02 RELATED REQUIREMENTS

- A. Section 01 40 00 - Quality Requirements: Additional requirements relating to testing agencies and testing.
- B. Section 03 30 00 - Cast-in-Place Concrete: Moisture emission reducing curing and sealing compound for slabs to receive adhered flooring, to prevent moisture content-related flooring failures; to remain in place, not to be removed.

1.03 REFERENCE STANDARDS

- A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens); 2023.
- B. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete; 2020.
- C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- D. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.
- E. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

- A. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
 - 1. Moisture and alkalinity (pH) limits and test methods.
 - 2. Manufacturer's required bond/compatibility test procedure.
- B. Testing Agency's Report:
 - 1. Description of areas tested; include floor plans and photographs if helpful.
 - 2. Summary of conditions encountered.
 - 3. Moisture and alkalinity (pH) test reports.

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Common Work Results for
Flooring Preparation
09 05 61 - 1

4. Copies of specified test methods.
 5. Recommendations for remediation of unsatisfactory surfaces.
 6. Product data for recommended remedial coating.
 7. Submit report directly to Owner.
 8. Submit report to Architect.
 9. Submit report not more than two business days after conclusion of testing.
- C. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.
1. Manufacturer's qualification statement.
 2. Manufacturer's statement of compatibility with types of flooring applied over remedial product.
 3. Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.
 4. Manufacturer's installation instructions.
 5. Specimen Warranty: Copy of warranty to be issued by coating manufacturer and certificate of underwriter's coverage of warranty.

1.06 QUALITY ASSURANCE

- A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.
- B. Contractor may perform adhesive and bond test with Contractor's own personnel or hire a testing agency.
- C. Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.
1. Submit evidence of experience consisting of at least 3 test reports of the type required, with project Owner's project contact information.
 2. Acceptable Testing Agencies:
 - a. Independent Floor Testing & Inspection, Inc. (IFTI): www.ifti.com/#sle.
 - b. Substitutions: See Section 016000.
- D. Contractor's Responsibility Relating to Independent Agency Testing:
1. Provide access for and cooperate with testing agency.
 2. Confirm date of start of testing at least 10 days prior to actual start.
 3. Allow at least 4 business days on site for testing agency activities.
 4. Achieve and maintain specified ambient conditions.
 5. Notify Owner when specified ambient conditions have been achieved and when testing will start.
 6. Notify Architect when specified ambient conditions have been achieved and when testing will start.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, handle, and protect products in accordance with manufacturer's instructions and recommendations.
- B. Deliver materials in manufacturer's packaging; include installation instructions.
- C. Keep materials from freezing.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.

- B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
 - 1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
 - 2. Latex or polyvinyl acetate additions are permitted; gypsum content is prohibited.
 - 3. Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.
 - 4. Products:
 - a. ARDEX Engineered Cements; ARDEX Feather Finish: www.ardexamericas.com/#sle..
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Alternate Flooring Adhesive: Floor covering manufacturer's recommended product, suitable for the moisture and pH conditions present; low-VOC. In the absence of any recommendation from flooring manufacturer, provide a product recommended by adhesive manufacturer as suitable for substrate and floor covering and for conditions present.
- C. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
 - 1. Thickness: 1/8 inch, maximum.
 - 2. Thickness: As required for application and in accordance with manufacturer's installation instructions.
 - 3. Products:
 - a. ARDEX Engineered Cements; ARDEX VB 100: www.ardexamericas.com/#sle.
 - b. Custom Building Products; TechMVC Moisture Vapor and Alkalinity Barrier: www.custombuildingproducts.com/#sle.
 - c. Floor Seal Technology, Inc; MES 100 with Floor Seal FloorCem SLU: www.floorseal.com/#sle.
 - d. Koster American Corporation; Koster VAP I 2000 with Koster SL Premium overlay: www.kosterusa.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Remedial Floor Sheet Membrane: Pre-formed multi-ply sheet membrane installed over concrete subfloor and intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
 - 1. Thickness: 24 mil (0.024 inch).

PART 3 EXECUTION

3.01 CONCRETE SLAB PREPARATION

- A. Perform following operations in the order indicated:
 - 1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:

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Common Work Results for
Flooring Preparation
09 05 61 - 3

- a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
 - b. Removal of existing floor covering.
 2. Existing concrete slabs with coatings or penetrating sealers/hardeners/dustproofers:
 - a. Do not attempt to remove coating or penetrating material.
 - b. Do not abrade surface.
 3. Preliminary cleaning.
 4. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.
 5. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
 6. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
 7. Specified remediation, if required.
 8. Patching, smoothing, and leveling, as required.
 9. Other preparation specified.
 10. Adhesive bond and compatibility test.
 11. Protection.
- B. Remediations:
1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.
 2. Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating or remedial sheet membrane over entire suspect floor area.
 3. Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

3.02 PRELIMINARY CLEANING

- A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.
- B. Do not use solvents or other chemicals for cleaning.

3.03 MOISTURE VAPOR EMISSION TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.
- C. Test in accordance with ASTM F1869 and as follows.
- D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.
- E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.

- F. Report: Report the information required by the test method.

3.04 INTERNAL RELATIVE HUMIDITY TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.
- C. Test in accordance with ASTM F2170 Procedure A and as follows.
- D. Testing with electrical impedance or resistance apparatus may not be substituted for the specified ASTM test method, as the values determined are not comparable to the ASTM test values and do not quantify the moisture content sufficiently.
- E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.
- F. Report: Report the information required by the test method.

3.05 ALKALINITY TESTING

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

3.06 PREPARATION

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

3.07 ADHESIVE BOND AND COMPATIBILITY TESTING

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

3.08 APPLICATION OF REMEDIAL FLOOR COATING

- A. Comply with requirements and recommendations of coating manufacturer.

3.09 INSTALLATION OF REMEDIAL FLOOR SHEET MEMBRANE

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

3.10 PROTECTION

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

END OF SECTION 09 05 61

**SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Metal channel ceiling framing.
- D. Acoustic insulation.
- E. Gypsum sheathing.
- F. Gypsum wallboard.
- G. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 07 84 00 - Firestopping: Top-of-wall assemblies at fire-resistance-rated walls.
- D. Section 07 92 00 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.
- E. Section 09 30 00 - Tiling: Tile backing board.

1.03 REFERENCE STANDARDS

- A. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.
- D. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.
- E. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).
- F. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
- G. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- H. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2023.
- I. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.
- J. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- K. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.
- L. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2018.

- M. ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing; 2018 (Reapproved 2023).
- N. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
- O. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
- P. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- Q. ASTM E413 - Classification for Rating Sound Insulation; 2022.
- R. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of gypsum board assemblies with size, location, and installation of service utilities.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- C. Installer's Qualification Statement.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing gypsum board installation and finishing, with minimum 5 years of experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.
- C. Store metal products to prevent corrosion.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
- B. Interior Partitions, Indicated as Sound-Rated: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC as indicated calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- C. Shaft Walls fire wall: Provide completed assemblies adjacent to existing walls.
 - 1. Fire rating as noted on the drawings.
- D. Fire Rated Assemblies: Provide completed assemblies as noted on the drawings

2.02 METAL FRAMING MATERIALS

- A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
- B. Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. ClarkDietrich: www.clarkdietrich.com/#sle.
 - 2. Jaimes Industries: www.jaimesind.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.

- C. Nonstructural Framing System Components: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
 - 1. Studs: C-shaped with knurled or embossed faces.
 - 2. Runners: U shaped, sized to match studs.
 - 3. Ceiling Channels: C-shaped.
 - 4. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
- D. Shaft Wall Studs and Accessories: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
- E. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as indicated on drawings.
- F. Deflection and Firestop Track: Intumescent strip factory-applied to track flanges expands when exposed to heat or flames to provide a perimeter joint seal.
 - 1. Products:
 - a. ClarkDietrich; BlazeFrame Firestop Deflection Track: www.clarkdietrich.com/#sle.
- G. Preformed Top Track Firestop Seal:
 - 1. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
 - 2. Products:
 - a. 3M Top Track Seal product: www.3m.com.
- H. Non-structural Framing Accessories:
 - 1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
 - 2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
 - a. Height: 35-3/4 inches.
 - b. Products:
 - 1) ClarkDietrich; Pony Wall (PW): www.clarkdietrich.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 - 3. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.
 - a. Products:
 - 1) ClarkDietrich; FastBridge Clip (FB33): www.clarkdietrich.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 - 1. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 - 2. National Gypsum Company: www.nationalgypsum.com/#sle.
 - 3. USG Corporation; ____: www.usg.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - 2. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 5/8 inch.
 - c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
 - 3. Paper-Faced Products:

- a. CertainTeed Corporation; Type C Drywall: www.certainteed.com/#sle.
 - b. CertainTeed Corporation; Type X Drywall: www.certainteed.com/#sle.
 - c. Georgia-Pacific Gypsum; ToughRock: www.gpgypsum.com/#sle.
 - d. Georgia-Pacific Gypsum; ToughRock Fireguard X: www.gpgypsum.com/#sle.
 - e. Georgia-Pacific Gypsum; ToughRock Fireguard C: www.gpgypsum.com/#sle.
 - f. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond Fire-Shield Gypsum Board: www.goldbondbuilding.com/#sle.
 - g. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond Fire-Shield C 5/8" Gypsum Board: www.goldbondbuilding.com/#sle.
 - h. USG Corporation; Sheetrock Brand EcoSmart Panels Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.
 - i. USG Corporation; Sheetrock Brand Firecode X Panels 5/8 in. (15.9 mm): www.usg.com/#sle.
4. Mold-Resistant, Paper-Faced Products:
- a. CertainTeed Corporation; M2Tech 5/8" Type X Moisture & Mold Resistant Drywall: www.certainteed.com/#sle.
 - b. Georgia-Pacific Gypsum; ToughRock Mold-Guard: www.gpgypsum.com/#sle.
 - c. Georgia-Pacific Gypsum; ToughRock Fireguard X Mold-Guard: www.gpgypsum.com/#sle.
 - d. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Gypsum Board: www.goldbondbuilding.com/#sle.
 - e. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Fire-Shield Gypsum Board: www.goldbondbuilding.com/#sle.
 - f. USG Corporation; Sheetrock Brand EcoSmart Panels Mold Tough Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.
 - g. USG Corporation; Sheetrock Brand Mold Tough Firecode SCX Panels 5/8 in. (15.9 mm): www.usg.com/#sle.
5. Glass Mat Faced Products:
- a. Georgia-Pacific Gypsum; DensArmor Plus: www.gpgypsum.com/#sle.
 - b. Georgia-Pacific Gypsum; DensArmor Plus Fireguard C: www.gpgypsum.com/#sle.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Interior Extreme Fire-Shield Gypsum Panel: www.goldbondbuilding.com/#sle.
 - d. USG Corporation; Sheetrock Brand Glass-Mat Panels Mold Tough Regular 5/8 in. (15.9 mm): www.usg.com/#sle.
- C. Backing Board For Wet Areas:
- 1. Application: Surfaces behind tile in wet areas including tub and shower surrounds, shower ceilings, and other wet areas.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
 - a. Regular Type: Thickness 5/8 inch.
 - b. Fire-Resistance-Rated Type: Type X core, thickness 5/8 inch.
 - c. Products:
 - 1) Georgia-Pacific Gypsum; DensShield Tile Backer: www.gpgypsum.com/#sle.
 - 2) Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Tile Backer: www.goldbondbuilding.com/#sle.
 - 3) USG Corporation; Durock Brand Glass-Mat Tile Backerboard 5/8 in. (15.9 mm): www.usg.com/#sle.
 - 4) USG Corporation; Durock Brand Glass-Mat Tile Backerboard SGX 5/8 in. (15.9 mm): www.usg.com/#sle.

- D. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.
1. ONLY REQUIRED FOR PATCHING TO MATCH BUILDING ENVELOPE SHEATHING DUE TO NEW PENETRATIONS (CURBS, PIPING, ETC.)
 2. Application: Exterior sheathing, unless otherwise indicated.
 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 4. Paper-Faced Sheathing: Gypsum sheathing board as defined in ASTM C1396/C1396M, moisture-resistant type with water repellent paper faces.
 5. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 6. Core Type: Regular and Type X, as indicated.
 7. Type X Thickness: 5/8 inch.
 8. Regular Board Thickness: 5/8 inch.
 9. Edges: Square.
 10. Glass Mat Faced Products:
 - a. CertainTeed Corporation; GlasRoc Type X Exterior Sheathing: www.certainteed.com/#sle.
 - b. Georgia-Pacific Gypsum; DensGlass Sheathing: www.gpgypsum.com/#sle.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Sheathing: www.goldbondbuilding.com/#sle.
 - d. USG Corporation; Securock Brand UltraLight Glass-Mat Sheathing Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.
- E. Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
1. Paper-Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C1396/C1396M; water-resistant faces.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.

2.04 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: 2 inch.
- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- C. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
1. Types: As detailed or required for finished appearance.
 2. Special Shapes: In addition to conventional corner bead and control joints, provide U-bead at exposed panel edges.
 - a. Control joints: V-shaped metal with factory-installed protective tape
 3. Products:
 - a. Same manufacturer as framing materials.
- D. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
1. Paper Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
 2. Joint Compound: Drying type, vinyl-based, ready-mixed.
- E. Finishing Compound: Surface coat and primer, takes the place of skim coating.
- F. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.

- G. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
 - 1. Fasten runners to structure with short leg to finished side, using appropriate power-driven fasteners at not more than 24 inches on center.
 - 2. Install studs at spacing required to meet performance requirements.
- B. Shaft Wall Liner: Cut panels to accurate dimensions and install sequentially between special friction studs.

3.03 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C1007/AISI S220 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
- C. Studs: Space studs at 16 inches on center.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
 - 3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Blocking: Install wood blocking for support of:
 - 1. Wall-mounted cabinets.
 - 2. Plumbing fixtures.
 - 3. Toilet accessories.
 - 4. Wall-mounted door hardware.

3.04 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.05 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations. Fastener type and spacing for each application refer to manufacturer's recommendations/requirements.
- B. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- C. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.
- D. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.

3.06 INSTALLATION OF TRIM AND ACCESSORIES

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

3.07 JOINT TREATMENT

- A. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
 - 2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 3. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- B. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
- C. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.08 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.09 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

3.10 PROTECTION

- A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION 09 21 16

**SECTION 09 30 00
TILING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Cementitious backer board as tile substrate.
- D. Non-ceramic trim.

1.02 RELATED REQUIREMENTS

- A. Section 03 54 00 - Cast Underlayment.
- B. Section 07 13 00 - Sheet Waterproofing.
- C. Section 07 14 00 - Fluid-Applied Waterproofing.
- D. Section 07 92 00 - Joint Sealants: Sealing joints between tile work and adjacent construction and fixtures.
- E. Section 09 21 16 - Gypsum Board Assemblies: Tile backer board.
- F. Section 09 24 00 - Cement Plastering: Lath and Portland cement scratch coat, where required by the TCNA (HB) or TCNA (HB-GP) method specified.

1.03 REFERENCE STANDARDS

- A. ANSI A108/A118/A136 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2019.
- B. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar; 2017 (Reaffirmed 2022).
- C. ANSI A108.1b - American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar; 2017.
- D. ANSI A108.1c - Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar; 1999 (Reaffirmed 2021).
- E. ANSI A108.2 - American National Standard General Requirements: Materials, Environmental and Workmanship; 2019.
- F. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesive or Water Cleanable Tile-Setting Epoxy Adhesive; 2019.
- G. ANSI A108.5 - American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar; 2021.
- H. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grout Epoxy; 1999 (Reaffirmed 2019).
- I. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout; 1999 (Reaffirmed 2019).
- J. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout; 1999 (Reaffirmed 2019).
- K. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework; 2017 (Reaffirmed 2022).

- L. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units; 2018.
- M. ANSI A108.12 - American National Standard for Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar; 1999 (Reaffirmed 2019).
- N. ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone; 2005 (Reaffirmed 2021).
- O. ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar; 2020.
- P. ANSI A108.20 - American National Standard Specifications for Exterior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs; 2020.
- Q. ANSI A118.1 - American National Standard Specifications for Dry-Set Cement Mortar; 2019.
- R. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive; 2021.
- S. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar; 2019.
- T. ANSI A118.5 - American National Standard Specifications for Chemical Resistant Furan Mortars and Grouts for Tile Installation; 1999 (Reaffirmed 2021).
- U. ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation; 2019.
- V. ANSI A118.7 - American National Standard Specifications for High Performance Cement Grouts for Tile Installation; 2019.
- W. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 2019.
- X. ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone; 2014 (Reaffirmed 2019).
- Y. ANSI A118.11 - American National Standard Specifications for EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar; 2017.
- Z. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 2014 (Reaffirmed 2019).
- AA. ANSI A118.13 - American National Standard Specification for Bonded Sound Reduction Membranes for Thin-Set Ceramic Tile Installation; 2014 (Reaffirmed 2019).
 - 1. ANSI A118.15 - American National Standard Specifications for Improved Modified Dry-Set Cement Mortar; 2019.
- BB. ANSI A136.1 - American National Standard Specifications for Organic Adhesives for Installation of Ceramic Tile; 2020.
- CC. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2022.
- DD. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- EE. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2023.
- FF. ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products; 2018 (Reapproved 2023).

- GG. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2018.
- HH. ASTM D4068 - Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane; 2017 (Reapproved 2022).
- II. ASTM E492 - Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine; 2022.
- JJ. ASTM E2179 - Standard Test Method for Laboratory Measurement of the Effectiveness of Floor Coverings in Reducing Impact Sound Transmission Through Concrete Floors; 2021.
- KK. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- LL. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.
- MM. ICC-ES AC308 - Acceptance Criteria for Termite Physical Barrier Systems; 2021, with Editorial Revision (2022).
- NN. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2024.
- OO. TCNA (HB-GP) - Handbook for Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs Installation; 2023.
- PP. ISO 13007 Standards for ceramic tiles, grouts and adhesives.
- QQ. ASTM C 1028 - standard test method for determining the static coefficient of friction on ceramic tile and other like surfaces by the horizontal dynamometer pull meter method.
- RR. ASTM C 4397 - standard specification for polyethylene sheeting for construction, industrial, and agricultural applications.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Installer's Qualification Statement:
 - 1. Submit documentation of National Tile Contractors Association (NTCA) or Tile Contractors' Association of America (TCAA) accreditation.
 - 2. Submit documentation of completion of apprenticeship and certification programs.
- D. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Tile: 1 percent of each size, color, and surface finish combination, but not less than 10 of each type.

1.05 QUALITY ASSURANCE

- A. Maintain one copy of ANSI A108/A118/A136, TCNA (HB), and TCNA (HB-GP) on-site.
- B. Installer Qualifications:
 - 1. Company and foreman on the jobsite specializing in performing tile installation, with minimum of five years of documented experience.
 - a. Prefer Accredited Five-Star member of the National Tile Contractors Association (NTCA) or Trowel of Excellence member of the Tile Contractors' Association of America (TCAA).
 - 2. Preferred Installer Certification:

- a. Ceramic Tile Education Foundation (CTEF): Certified Tile Installer (CTI).
- b. Apprenticeship Program: Installer has achieved Journeyworkers status through an apprenticeship from the International Union of Bricklayers and Allied Craftworkers (IUBAC) or a U.S. Department of Labor (DOL)-recognized program.
- c. Advanced Certifications for Tile Installers (ACT): Certification in the installation of membranes, mortar bed (mud) floors, mortar (mud) walls, shower receptors, large format tile, gauged porcelain tile/panels/slabs, and grouts.
- d. International Masonry Training and Education Foundation (IMTEF): Supervisor Certification Program (SCP).

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.
- B. Deliver and store materials on site at least 24 hours before work begins. Provide heated and dry storage facilities on site.
- C. Prevent damage or contamination to materials by water, freezing, overheating, foreign matter or other causes.
- D. Store tile and setting materials on elevated platforms, under cover and in a dry location.

1.07 FIELD CONDITIONS

- A. Do not install solvent-based products in an unventilated environment.
- B. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting materials.
- C. Vent temporary heaters to exterior to prevent damage to tilework from carbon dioxide build-up.
- D. Do not install adhesives in an unventilated environment.
- E. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.

PART 2 PRODUCTS

2.01 TILE

- A. Manufacturers:
 1. Dal-Tile Corporation: www.daltile.com/#sle.
- B. Glazed Wall Tile, Type CT6A: COLORWHEEL CLASSICS .
 1. Size: 3 by 6 inch, nominal.
 2. Surface Finish: High gloss.
 3. Color(s): As indicated on drawings.
 4. Trim Units: Surface bullnose along all exposed edges of 3x6 tile
 5. Products:
 - a. Dal-Tile Corporation; ____: www.daltile.com/#sle.
- C. Glazed Wall Tile, Type CT7: COLORWHEEL LINEAR
 1. Size: 4 by 16 inch, nominal
 2. Surface Finish: High gloss
 3. Color: As indicated on drawings
 4. Trim Units: Schluter Jolly trim on exposed edges
 5. Products:
 - a. Dal-Tile Corporation: www.daltile.com/#sle.
- D. Porcelain Tile, Type PT2A: PORTFOLIO .
 1. Size: 12 BY 24 inch, nominal.
 2. Surface Finish: MATTE .
 3. Color(s): As indicated on drawings.

4. Trim Units: Schluter Schiene AT & Schluter Dilex-AHAK-AT; reference drawings
5. Products:
 - a. Dal-Tile Corporation: www.daltile.com/#sle.

2.02 STANDARDS

- A. ANSI ceramic tile standard: provide tile that complies with ANSI A137.1 for types compositions and other characteristics indicated.
 1. Provide tile complying with standard grade requirements.
 2. Refer to finish schedule key in the construction document drawings for specific finish materials and color selections.
- B. ANSI A118 standards for tile installation materials: provide materials complying with ANSI A108.02, ANSI standards referenced in other part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules and other requirements specified.
- C. ISO 13007 standards for ceramic tiles, grouts and adhesives: provide materials complying with ISO 13007 standards.
- D. Factory blending: for tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved samples.
- E. Mounting: for factory-mounted tile, provide back or edge mounted tile assemblies as standard with manufacturer unless otherwise indicated.
- F. Factory applied temporary protective coatings: where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by pre-coating with a continuous film of petroleum paraffin wax applied hot. Do not coat unexposed tile surfaces.
- G. Ceramic tile types: Shall comply with ANSI A137.1
- H. Static Coefficient of friction: tile on walkway surfaces shall be provided with the following values as determined by testing in conformance with ASTM C1028.
 1. Level surfaces: minimum of 0.6 (wet).
- I. Dynamic Coefficient of friction:
 1. ANSI A326.american national standard test method for measuring dynamic coefficient of friction of hard surface flooring materials.
 - a. ANSI A137.1 and ANSI A137.3, dcof acutest.
 - b. Level surfaces: minimum of 0.42 (wet).

2.03 TRIM AND ACCESSORIES

- A. Non-Ceramic Trim: Brushed stainless steel, style and dimensions to suit application, for setting using tile mortar or adhesive.
 1. Applications:
 - a. Wall tile exposed edges, wall corners (inside and outside):
 - 1) Schluter Systems, "Jolly", straight and/or radius applications.
 - (a) Standard finish shall be brushed stainless steel, unless noted otherwise.
 - (b) Provide accessory trim pieces in finish specified.
 - 2) Schluter Systems, "Quadec", square reveal, straight applications.
 - (a) Standard finish shall be brushed stainless steel, unless noted otherwise.
 - (b) Provide accessory trim pieces in finish specified.
 - b. Transition between floor finishes of different heights.
 - 1) Schluter Systems, "Reno-tk", straight and/or radius applications.
 - 2) Standard finish shall be satin anodized aluminum, unless noted otherwise.

- (a) Other manufactured standard finish colors. Color shall be noted in the construction document color schedule key with the appropriate tile.
 - (b) All sizes compliant with ada.
 - 3) Schluter Systems, "Reno-u", straight applications.
 - (a) Standard finish shall be satin anodized aluminum, unless noted otherwise.
 - (b) Other manufactured standard finish colors. Color shall be noted in the construction document color schedule key with the appropriate tile.
 - (c) Install only ADA compliant size(s).
 - c. Same height transitions at floors.
 - 1) Schluter Systems, "Schiene", straight and/or radius applications.
 - (a) Standard finish shall be satin anodized aluminum.
 - (b) Other manufactured standard finish colors. Color shall be noted in the construction document color schedule key with the appropriate tile.
 - 2) Schluter Systems, "Reno-t"
 - (a) Standard finish shall be satin anodized aluminum.
 - (b) Other manufactured standard finish colors. Color shall be noted in the construction document color schedule key with the appropriate tile.
 - d. Cove transitions between wall and floors:
 - 1) Schluter Systems "Schiene-AT", top of cut tile base between base and wall tile.
 - 2) Schluter Systems "Dilex-AHKA-AT", bottom of cut tile base along floor.
- 2. Products:
 - a. Schluter-Systems: www.schluter.com/#sle.

2.04 SETTING MATERIALS

- A. Manufacturers:
 - 1. LATICRETE International, Inc: www.laticrete.com/#sle.
 - 2. Mapei Corporation: www.mapei.com/#sle.
- B. Iso 13007 performance requirements for adhesives (mortars or mortar adhesives).
- C. Performance requirements for adhesives cementitious mortars (thin-set).
 - 1. C1 – normal: tensile bond strength of greater than or equal to 72.5 psi.
 - a. C2 – improved: tensile bond strength of greater than or equal to 145 psi.
 - 2. Performance characteristics for adhesives
 - a. F – fast setting/fast drying
 - b. T – thixotropic (non-slip/non-sag)
 - c. S1 – normal deformity greater than or equal to 0.1" and 0.2".
 - d. S2 – improved deformity greater than or equal to 0.2".
 - e. P1 – normal plywood adhesion bond strength.
 - f. P2 – improved plywood adhesion bond strength.
- D. Premium, Rapid-Setting, Flexible Tile Mortar
 - 1. Fast setting mortar for use with thin set installation method of large and heavy tile:
 - a. Latex modified hydraulic cement mortar; two-component system, of hydraulic mortar and flexible liquid polymer additive complying with ANSI A118.4, ANSI A118.15 and ISO 13007 C2FS2P2, equal to Mapei Corp., "Granirapid System".
 - b. Product is ready for light traffic after approximately 3 hours and completely cured in 24 hours. It is resistant to impact, vibration, temperature changes, aging and mild cleaning chemicals.
- E. Mortar Bed
 - 1. Factory blended, cement-based, polymer-modified thick-bed and render mortar complying with ANSI A108.1, equal to Mapei Corp., "Modified Mortar Bed".

- a. Applications: Interior floor installation at shower and /or wet area(s). Refer to architectural details in construction document set.
 - b. Install wire reinforcement in areas greater than 65 square feet.
- F. Improved Latex-Portland Cement Mortar Bond Coat: ANSI A118.15.
- 1. Applications:
 - a. Use this type of bond coat where Large and Heavy Tile (LHT) mortar is indicated.
 - b. Interior floor and wall tile installations.
 - 2. Products:
 - a. ANSI A118.11, A118.4, A118.15HTE and ISO 13007 C2TES1P1, equal to Mapei Corp., "Ultraflex LFT or Keraflex Super".
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 ADHESIVES AND PRIMERS

- A. A "bond coat" is different from a "mortar bond coat" as specified in the TCNA installation methods. This bond coat acts as a bonding agent to existing concrete, thereby increasing the adhesion of the setting or leveling mortar.
- B. Modified dry-set mortar for use with tile, premium grade single component, high performance, polymer-modified mortar complying with ANSI A118.4E, ANSI A118.11 and ANSI A118.15E, ISO 13007 C2ES1P1, equal to Mapei Corp., UltraFlex "LFT or Keraflex Super"
- 1. Applications:
 - a. On structural concrete slab and with interior floor tile installations.
 - b. Clear glass with opaque color backing – Mapei Corp., "Keraflex Super", color: white.
 - c. Where called for by (TCNA) tile council of north america.
- C. Chemical cure resilient high-bond adhesive: white, flexible, two-component urethane adhesive, complying with iso 13007 R2, Mapei Corp., "Planicrete W".
- 1. Applications: for use with interior non-vitreous, semi-vitreous, vitreous and impervious mosaic wall tiles over non-porous and metal substrates. Do not use at showers and pools.

2.06 GROUTS

- A. Manufacturers:
- 1. LATICRETE International, Inc: www.laticrete.com/#sle.
 - 2. Mapei Corporation: www.mapei.com/#sle.
- Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
- 1. Color(s): As indicated on drawings.
 - 2. Products:
 - a. LATICRETE International, Inc; LATICRETE SPECTRALOCK PRO Premium Grout: www.laticrete.com/#sle.
- B. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
- 1. Color(s): As indicated on drawings.
 - 2. Products:
 - a. Mapei Corp.
 - 1) Premium epoxy grout and mortar: 100% solids epoxy grout and mortar with color-coated quartz, non-sagging/nonslumping in joints up to 3/8" in width, water cleanable, high stain resistance, no sealer required, complying with ANSI A118.3 and ISO 13007 RG classification R2/RG, equal to Mapei Corp., "Kerapoxy CQ".

2.07 SUPPORT AND ADDITIONAL MATERIALS

- A. Tile Sealant: Gunnable, 100% silicone sealant; moisture and mildew resistant type.
- 1. Applications:
 - a. Between tile and plumbing fixtures.

- b. Between tile and toilet accessory fixtures.
 - c. At expansion and movement joints, horizontal and vertical complying with ASTM standards; ASTM: meets C920, Type S, Grade NS, Class 25, use T1, T2, NT, I, M, G, A, ANO, and conforms to C794 adhesion properties.
 - 2. Color to match grout of adjacent tile.
 - 3. Matte sheen
 - 4. Products:
 - a. Mapei; MAPESIL T Plus
- B. Grout Release: Temporary, water-soluble pre-grout coating.
 - 1. Products:
 - a. Mapei; Ultracare Grout Release..
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Tile Cleaner
 - 1. A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers. Subject to compliance with requirements, equal to Mapei Corp. "UltraCare concentrated tile & grout cleaner", "UltraCare abrasive surface cleaner", "UltraCare acidic tile & grout cleaner".

2.08 SURFACE PREPARATION AND ACCESSORY MATERIALS

- A. Patching Compound:
 - 1. Fill cracks, holes and depressions in concrete substrates for tile floors with trowelable patching compound or self leveling underlayment specifically recommended by tile-setting material manufacturer. For tiles larger than 15 inches, flatten floor to within 1/8 inch in 10 feet prior to installing tile. For tiles less than 15 inches flatten floor to within 1/4 inch in 10 feet prior to installing tile.
 - 2. Trowel grade patch equal to Mapei Corp., "Mapecem Quickpatch".
 - 3. Self leveling underlayment equal to Mapei Corp., "Ultraplan Easy".
 - 4. Wall render and repair equal to Mapei Corp., "Planitop 330 Fast".
 - 5. Follow manufacturer's recommendations for product usage at specific locations/conditions.
- B. Waterproofing Membrane: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
 - 1. Crack Resistance: No failure at 1/16 inch gap, minimum; comply with ANSI A118.12.
 - 2. Install waterproof membranes under thin set tile installations complying with ANSI A118.10, TCNA B421C shower/wet area floor and TCNA B420 for shower/wet area walls. Include reinforcement and accessories as recommended by manufacture for the application.
 - a. Fluid-applied membrane: premixed, advanced liquid-rubber, quick-drying waterproofing and crack-isolation membrane, equal to Mapei Corp., "Mapelastic Aquadefense".
 - b. In conjunction with fluid-applied waterproofing membrane use Mapei Corp., "Reinforcing Fabric" and/or Mapei Corp., "Mapeband" waterproofing membranes at corners, coves, drains, expansion and movement joints.
 - 3. Do not use where excessive substrate moisture and/or where negative hydrostatic pressure exists. Maximum allowable moisture is 8 lbs per 1,000 sq. Ft. Per 24 hours per ASTM F1869 or up to 85% relative humidity as measured with moisture probes.
 - 4. Concrete substrates should have a concrete surface profile of #2 per the international concrete repair institute (ICRI). Mechanically clean and profile by diamond-cup grinding or other engineer-approved method.
 - 5. Substrate and room temperatures above 50 degree Fahrenheit to 100 degree Fahrenheit during and at least 24 hours after application per ANSI A108.02.2.2.

6. Refer to architectural detail for shower and/or wet areas.
 7. Membranes must be protected to prevent punctures resulting from traffic on the membrane before the tile is installed.
 8. Preform flood testing per ASTM D5957, allow waterproof membranes to cure per Mapei Corporation instructions.
- C. Backer Board
1. Shower walls and ceiling: coated glass mat water-resistant backer board equal to Georgia Pacific, "DensShield" as specified in section 09 21 16 gypsum board system and architectural drawings.
 2. Non-wet walls at toilet rooms with showers: moisture resistant gypsum board and/or type "X" fire rated moisture resistant gypsum board as specified in section 09 21 16 Gypsum Board System and architectural drawings.
 3. Non-wet walls: gypsum wall board as specified in section 09 21 16 Gypsum Board System and architectural drawings.
- D. Prefabricated substrates
1. Install prefabricated substrate sheet similar to Schluter Systems, "Kerdi-board", or "Mapeguard Board" when tiles abutting to each other of dissimilar thicknesses. Install prefabricated substrate sheet behind tile of lesser thickness so for it to be level and flush with adjacent tile.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- B. Verify that subfloor surfaces are dust free and free of substances that could impair bonding of setting materials to subfloor surfaces.
- C. Cementitious Subfloor Surfaces: Verify that substrates are ready for tiling installation by testing for moisture and alkalinity (pH).
 1. Obtain instructions if test results are not within limits recommended by tiling material manufacturer and setting material manufacturer.
 2. Follow moisture and alkalinity remediation procedures in Section 09 05 61.
- D. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:
 1. Moisture Emission Rate: Not greater than 3 lb per 1000 sq ft per 24 hours, test in accordance with ASTM F1869.
 2. Alkalinity (pH): Verify pH range of 5 to 9, test in accordance with ASTM F710.
- E. Verify that required floor-mounted utilities are in correct location.
- F. Substrate and room temperatures above 50 degree Fahrenheit to 100 degree Fahrenheit during and at least 24 hours after application per ANSI A108.02.2.2. Temperature of the substrate should be 60 degrees Fahrenheit and rising for application of epoxy.

3.02 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Fill cracks, holes and depressions in concrete substrates for tile floors with trowelable patching compound or self leveling underlayment specifically recommended by tile-setting material manufacturer. For tiles larger than 15 inches, flatten floor to within 1/8 inch in 10 feet prior to

installing tile. For tiles less than 15 inches flatten floor to within ¼ inch in 10 feet prior to installing tile.

1. Trowel grade patch equal to Mapei Corp., "Mapecem Quickpatch".
 2. Self leveling underlayment equal to Mapei Corp., "Ultraplan Easy".
 3. Wall render and repair equal to Mapei Corp., "Planitop 330 Fast".
 4. Follow manufacturer's recommendations for product usage at specific locations/conditions.
- E. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.
- F. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

- A. Install tile and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) or TCNA (HB-GP) recommendations, as applicable.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- E. Form internal angles square and external angles square.
- F. Install ceramic accessories rigidly in prepared openings.
- G. Sound tile after setting. Replace hollow sounding units.
- H. Keep control and expansion joints free of mortar, grout, and adhesive.
- I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- J. Grout tile joints unless otherwise indicated.
- K. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.
- L. Comply with the tile council of north American (TCNA) (the most current edition) handbook for ceramic, glass, and stone tile installation including addendum's. Comply with parts of the ANSI A108 series "specifications for installation of ceramic tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
- M. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
1. Apply a thin coat of mortar with the flat edge of the trowel to achieve a good mechanical bond to the substrate. Then apply mortar with the appropriate size notch trowel per the tile manufacturer recommendation.
 2. Re-comb the mortar with a notched trowel if any evidence of skinning or setting is evident. Apply mortar to an area no greater than can be tiled in 30-45 minutes. Always test the bond of back-mounted sheets of tile to insure adhesion of the full sheet.
 3. Tile should be applied into a fresh bed of mortar and pushed perpendicular to trowel lines to knock down trowel ridges and achieve specified mortar coverage.
 4. Maintain a finished mortar bed 3/32" minimum and 1 ½" maximum thickness.
- N. Location and frequency of movement joints-per EJ-171
1. Interior: maximum 25' in each direction.

2. Interior tile work exposed to direct sunlight (heat) or moisture: maximum 12' in each direction.
 3. Above ground concrete slab substrate: maximum 12' in each direction.
 4. Interior perimeter joints: movement joints are required where tilework abuts restraining surfaces such as perimeter walls, dissimilar floor finishes, curbs, columns, pipes, ceilings and where changes occur in backing materials but not at drain strainers.
 5. Perimeter joints – movement joints are required where tilework abuts restraining surfaces such as perimeter walls, dissimilar floors, curbs, columns, pipes, ceilings and where changes occur in backing materials but not at drain strainers. All expansion, control, construction, cold, saw-cut, isolation, contraction and seismic joints in the structure should continue through the tilework, including such joints at vertical surfaces. Where tile pattern falls diagonally across a saw-cut joint, relocation of the movement joint is specifically not recommended because of the reduced performance of the sealant when used in a saw tooth or other non-linear fashion.
 6. Interior change of plane – movement joints required at all inside corners
 7. All expansion, control, construction, cold, saw-cut, isolation, contraction, and seismic joints in the structure should continue through the tilework, including such joints at vertical surfaces.
 8. Exterior: 8' to 12' in each direction.
 9. Refer to structural engineer drawings in construction document drawing set for the locations of construction/cold joints, expansion joints, isolations joints and acoustical joint.
 10. Refer to architectural floor plan or floor finish plan in the construction document drawing set for the location of contraction/control joints.
 11. Contractor should review architect's movement joint locations and details and advice architect if changes need to occur for best results for tile application(s).
- O. Expansion Joint widths:
1. Interior for quarry tile and paver tile: same as grout joint, but not less than 1/4".
 2. Interior for ceramic mosaic tile and glazed wall tile: preferred not less than 1/4" but never less than 1/8".
 3. Joints in tile and setting materials shall never be less than the width of the saw-cut control joint width.
 4. Joints through tilework directly over structural joints must never be narrower than the structural joint.
 5. Exterior tile: minimum 3/8" for joints 8' on center, minimum 1/2" for joints 12' on center. Minimum widths must be increased 1/16" for each 15 degree Fahrenheit tile surface temperature change greater than 100 degree Fahrenheit between summers high and winter low.
- P. Grout joint size and patterns:
1. Grout joint size shall be in accordance with ANSI A108.02 section 4.3.8 for ceramic tile. The actual grout joint size shall be at least three times the actual variation of facial dimensions of the tile supplied. It will not be acceptable for a grout joint to be less than 1/16".
 2. Running bond/brick joint pattern shall be in accordance with ANSI A108 section 4.3.8.1 for ceramic tile. For running bond/brick joint pattern utilizing tile (square or rectangular) with any side greater than 15", the grout joint shall be, on average, a minimum of 1/8" wide for rectified tiles and, on average, a minimum of 3/16" wide for calibrated (non-rectified) tiles. The grout joint width shall be increased over the minimum requirement by the amount of edge warpage on the longest edge of the actual tiles being installed.

3.04 INSTALLATION GROUTING

- A. Grout joint width(s) shall be according to manufacturer's recommendation and tile council of north america (TCNA). Make grout joints watertight, without voids, cracks, excess mortar or excess grout.
- B. Grouting may begin only after a firm set has taken place. Set times will vary depending upon ambient, slab and material temperatures. Check tile manufacturer's literature to determine if the tile is suitable for use with colored grouts. Tiles with high absorption or rough, abrasive surfaces may require sealing with grout release prior to grouting to prevent permanent staining.
- C. Joints should be free of debris and foreign material. Ridges of adhesive, cement or thin-set should be raked out to at least 3/4 of the tile thickness in depth prior to application of grout.
- D. Float grout joints full using a 45 degree angle to the edge of the tile using a hard rubber float to insure maximum filling of the joint. Fill joints to full depth of the tile with no entrapped air bubbles. Apply as much pressure as possible on the rubber float when cleaning excess material from the tile face. The float should be held at a 90 degree angle to the surface of the floor and moved diagonally across the tile face.
- E. Final clean-up to remove the residue left after completing the application procedure should commence as soon as light pressure with a stiff, damp synthetic sponge will not pull grout from the joint. Rinse the sponge often in clean, warm water. If the grout drags out of the joint, wait 15 minutes as the clean-up is premature.
- F. Remove resin grout haze (epoxy or single-component ready-to-use) and remaining residue from the tile up to 6-8 hours after grouting with a white "Scotch-brite" pad and warm water.
- G. Caution: do not let grout material cure on the face of the tile as epoxies are extremely difficult to remove. If necessary, well cured epoxy modified grout may be removed from the face of the tile with water washable epoxy grout haze remover equal to Mapei "Ultracare Epoxy Grout Haze Remover". Caution: follow manufacturer's directions for safe use.

3.05 INSTALLATION OF SEALANTS

- A. Install movement joints per astm c1193 standard guide for use of joint sealants.
- B. Install movement joints TCNA EJ171 per tile council of north america (TCNA) (most current) handbook for ceramic, glass, and stone tile installation.
- C. Tile edges to which the sealant will bond must be clean and dry. Sanding or grinding of these edges is recommended to obtain optimum sealant bond.
- D. Ensure that location of joints in tilework align with existing joints in substrate, joints in tilework should be constructed during installation of mortar beds and/or tile, rather than saw-cutting joints after installation.
- E. Keep movement joint cavities open and free of dirt, debris, grout, mortar and setting materials.
- F. Set compressible backup strip when mortar is placed or utilize removable wood strip to provide space for backup after mortar has cured.
- G. Follow sealant manufacturer's recommendations.

3.06 INSTALLATION - FLOORS AND WALLS ALL AREAS EXCEPT SHOWER AND WET AREAS

- A. Install tile in accordance with Tile Council of North America (TCNA) (most current year) handbook for ceramic, glass, and stone tile installation including addendums, per detail(s) meeting TCNA environmental exposure classification COM1 (commercial dry).
 - 1. Install Mapei Corp., "Flexcolor CQ" acrylic solid grout on floors and walls at the following areas:
 - a. Adjacent to area(s) with TCNA environment exposure classification COM1 (commercial limited water exposure).
- B. Install tile in accordance with Tile Council of North America (TCNA) (most current year) handbook for ceramic, glass, and stone tile installation including addendums, per detail(s)

meeting TCNA environmental exposure classification COM2 (commercial limited water exposure).

1. Install Mapei Corp., "Kerapoxy CQ" 100% epoxy grout on floors and walls at the following areas:
 - a. Public toilets.
 - b. Staff toilets without a shower.
 - c. Corridors.
 - d. Backsplashes.
- C. Install tile in accordance with Tile Council of North America (TCNA) (most current year) handbook for ceramic, glass, and stone tile installation including addendums, per detail(s) meeting TCNA environmental exposure classification COM3 (commercial wet).
 1. Install Mapei Corp., "Kerapoxy CQ" 100% epoxy grout on floors and walls at the following areas:
 - a. Patient toilets and showers.
 - b. Staff toilets and showers.
 - c. Locker rooms.
 - d. Therapy pool decks.
- D. Install tile in accordance with Tile Council of North America (TCNA) (most current year) handbook for ceramic, glass, and stone tile installation including addendums, per detail(s) meeting TCNA environmental exposure classification COM3 (commercial wet).
 1. Install Mapei Corp., "Kerapoxy IEG CQ" 100% solids, industrial-grade epoxy grout on floors and walls at the following areas:
 2. Kitchen area with tile.
 3. Kitchen cart wash area with tile.
 4. Serving line.

3.07 INSTALLATION - WALL TILE

- A. On exterior walls install in accordance with TCNA (HB) Method W244, thin-set over cementitious backer units, with waterproofing membrane.
- B. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.
- C. Over gypsum wallboard on wood or metal studs install in accordance with TCNA (HB) Method W243, thin-set with dry-set or latex-Portland cement bond coat, unless otherwise indicated.

3.08 CLEANING

- A. Clean tile and grout surfaces.

3.09 PROTECTION

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

END OF SECTION 09 30 00

**SECTION 09 51 00
ACOUSTICAL CEILINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 07 21 00 - Thermal Insulation: Acoustical insulation.

1.03 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019.
- C. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
- D. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- E. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2022.
- F. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2023.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on suspension system components and acoustical units.
- C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.06 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum Five years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum Five years documented experience.

1.07 FIELD CONDITIONS

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

1.08 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acoustic Tiles/Panels:
1. Armstrong World Industries, Inc: www.armstrongceilings.com/#sle.
 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Suspension Systems:
1. Armstrong World Industries, Inc: www.armstrong.com/#sle. (Basis of Design)
 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Rating: Determined in accordance with test procedures in ASTM E119 and complying with the following:
1. UL (FRD) Assembly Design No. Class A.

2.03 ACOUSTICAL UNITS

- A. Acoustical Panels, Type ACT1B: Mineral fiber with scrubbable finish, with the following characteristics:
1. Classification: ASTM E1264 Type IX.
 2. Size: 24 by 24 inches.
 3. Thickness: 3/4 inch.
 4. Panel Edge: Square.
 5. Color: White.
 6. Products:
 - a. Armstrong, Ultima Health Zone.
- B. Acoustical Tile Type ACT6: Painted mineral fiber, with the following characteristics:
1. Size: 24 by 24 inches.
 2. Thickness: 3/4 inches.
 3. Edge: Angled Tegular.
 4. Surface Color: White.
 5. Surface Pattern: Fine Textured.
 6. Products:
 - a. Armstrong; Mesa

2.04 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
- B. Exposed Suspension System: Hot-dip galvanized steel grid and aluminum cap.
1. Structural Classification: Heavy-duty, when tested in accordance with ASTM C635/C635M.
 2. Profile: Exposed Tee; 15/16 inch face width.
 3. Finish: Baked enamel.
 4. Color: White
 5. Products:
 - a. Armstrong Prelude XL.

2.05 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.
- C. Hold-Down Clips: Manufacturer's standard clips to suit application.
- D. Perimeter Moldings: Same metal and finish as grid.
 - 1. Gaskets For Perimeter Moldings: Closed-cell foam, factory-applied to molding.
 - 2. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.
- E. Gypsum Board: Fire rated type; 5/8 inch thick, ends and edges square, paper faced.
- F. Hold down clips
- G. Adhesive for glue-on ceiling tile as recommended by Manufacturer.
- H. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.
- D. Locate system on room axis according to reflected plan.
- E. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
- F. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- G. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.
- H. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- I. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- J. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- K. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- L. Do not eccentrically load system or induce rotation of runners.

- M. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Install in bed of acoustical sealant.
 - 2. Use longest practical lengths.
 - 3. Overlap and rivet corners.
- N. Form expansion joints as detailed. Form to accommodate plus or minus 1 inch movement. Maintain visual closure.
- O. Install light fixture boxes constructed of gypsum board above light fixtures in accordance with fire rated assembly requirements and light fixture ventilation requirements.

3.03 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Lay directional patterned units with pattern parallel to longest room axis.
- D. Fit border trim neatly against abutting surfaces.
- E. Install units after above-ceiling work is complete.
- F. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- G. Cutting Acoustical Units:
 - 1. Cut to fit irregular grid and perimeter edge trim.
 - 2. Make field cut edges of same profile as factory edges.
 - 3. Double cut and field paint exposed reveal edges.
- H. Where round obstructions and bullnose concrete block corners occur, provide preformed closures to match perimeter molding.
- I. Lay acoustical insulation for a distance of 48 inches either side of acoustical partitions as indicated.
- J. Install hold-down clips on each panel to retain panels tight to grid system; comply with fire rating requirements.
- K. Construct light box with 5/8" Type -Xgypsum board above light fixtures in accordance with UL assembly requirements.
- L. Install hold-down clips on panels within 10 ft of an exterior door.
- M. Install safety clips on wood veneer panels 2 inches from outside edge of panel and at 24 inches on center.
 - 1. Use wire ties to attach safety clips.
- N. Install wood veneer trim using aluminum L angle to attach to suspended grid system as required for application.

3.04 TOLERANCES

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

END OF SECTION 09 51 00

**SECTION 09 65 00
RESILIENT FLOORING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient sheet flooring.
- B. Resilient base.
- C. Installation accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 03 54 00 - Cast Underlayment.
- C. Section 09 05 61 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.

1.03 REFERENCE STANDARDS

- A. ASTM D6329 - Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers; 1998 (Reapproved 2023).
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2023.
- C. ASTM F150 - Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring; 2006 (Reapproved 2018).
- D. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- E. ASTM C920-Standard Specifications for Performance in resilient flooring.
- F. ASTM F970 - Standard Test Method for Measuring Recovery Properties of Floor Coverings after Static Loading; 2022.
- G. ASTM F1303 - Standard Specification for Sheet Vinyl Floor Covering with Backing; 2004 (Reapproved 2021).
- H. ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile; 2020.
- I. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021.
- J. ASTM F1913 - Standard Specification for Vinyl Sheet Floor Covering Without Backing; 2019.
- K. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.
- L. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings; 2018.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
 - 1. All products shall be provided by the same manufacturer as a complete system.
- C. Shop Drawings: Indicate seaming plans and floor patterns.
- D. Concrete Testing Standard: Submit a copy of ASTM F710.
 - 1. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.

- E. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of subfloor is acceptable.
- F. According to flooring system manufacturer installation and product requirements, submit the following procedure and product installation:
 - 1. Concrete subfloor cleaning process to be used.
 - 2. Alkalinity- ph adjustment method and neutralizer method.
 - 3. Sub-Floor filler/leveler product.
 - 4. Primer product.
 - 5. out of range moisture emission sealant.
 - 6. Flooring adhesive products
 - a. Allow for manufacturer's high moisture emission and high relative humidity compatible adhesive.
 - b. Finish flooring sealer and or wax products, if required.
- G. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Flooring Material: 50 square feet of each type and color.
 - 3. Extra Wall Base: 50 linear feet of each type and color.

1.05 DELIVERY, STORAGE, AND HANDLING

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

1.06 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 SHEET FLOORING

- A. Vinyl Sheet Flooring - SV1D, SV2D, SV3D, SV4D: Homogeneous sheet
 - 1. Minimum Requirements: Comply with ASTM F1303, Type I, with Class A: 4-ply fused backing system of .080" content PVC layer, fiberglass, PVC internal layer, polyester mesh back. backing.
 - 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 3. VOC Content Limits: As specified in Section 01 61 16.
 - 4. Total Thickness: 0.080 inch minimum.
 - 5. Sheet Width: 6'-6" wide
 - 6. Seams: Heat welded.
 - 7. Color: As indicated on drawings.
 - 8. Manufacturer:
 - a. Tarkett; IQ Optima

- B. Welding Rod: Solid bead in material compatible with flooring, produced by flooring manufacturer for heat welding seams, and in color matching field color.

2.02 RESILIENT BASE

- A. Resilient Base: ASTM F1861, B5; Cove Coil Vinyl Base; Class A Flammability rating.
 - 1. Manufacturers:
 - a. Johnsonite, a Tarkett Company: www.johnsonite.com/#sle.
 - 2. Flammability: ASTM E84; Class A
 - 3. Height: 4 inch
 - 4. Thickness: 1/8 inch.
 - 5. Length: 120' Roll.
 - 6. Color: As indicated on drawings.
 - 7. Accessories: Premolded external corners and internal corners.

2.03 ACCESSORIES

- A. Subfloor Filler: Portland/hydraulic based latex compound; type recommended by adhesive material manufacturer. (NOTE: NO GYPSUM ALLOWED IN PRODUCTS)
- B. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
 - 1. VOC Content Limits: As specified in Section 01 61 16.
- C. Adhesive for Resilient Flooring: Per manufacturer recommendations.
- D. Moldings, Transition and Edge Strips: Same material as flooring.
- E. Filler for Coved Base: Plastic.
- F. Flash cove accessories per details on drawings and manufacturer recommendations.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
 - 1. Test in accordance with Section 09 05 61.
 - 2. Test in accordance with ASTM F710.
 - 3. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- D. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Remove existing resilient flooring and flooring adhesives; follow the recommendations of RFCI (RWP).
- B. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.
- C. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- D. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
- E. Prohibit traffic until filler is fully cured.

- F. Clean substrate.
- G. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 INSTALLATION - GENERAL

- A. The permanent HVAC system must be in operation before installing resilient flooring products.
 - 1. Starting installation constitutes acceptance of sub-floor conditions.
 - 2. Install in accordance with manufacturer's written instructions.
 - 3. Spread only enough adhesive to permit installation of materials before initial set.
 - 4. Fit joints and butt seams tightly.
 - 5. Set flooring in place, press with heavy roller to attain full adhesion.
 - 6. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
 - 7. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 - a. Metal Strips: Attach to substrate before installation of flooring using stainless steel screws.
 - b. Resilient Strips: Attach to substrate using adhesive.
 - 8. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
 - 9. Install flooring in recessed floor access covers, maintaining floor pattern.
 - 10. At movable partitions, install flooring under partitions without interrupting floor pattern.
 - 11. Install feature strips where indicated.

3.04 INSTALLATION - SHEET FLOORING

- A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.
- B. Seal seams by heat welding.
- C. Coved Base: Install as detailed on drawings, using coved base filler as backing at floor to wall junction. Extend sheet flooring vertically to height indicated, and cover top edge with metal cap strip.
- D. Clear silicone caulk at top cap and wall joint.
- E. Back roll and/or weight ends of sheet flooring during installation to eliminate the occurrence of bubbles and loose areas.
- F. Refer to manufacturer's recommendations for adhesives required where heavy rolling equipment is used, such as but not limited to patient beds.

3.05 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.
- D. Scribe and fit to door frames and other interruptions.
- E. Install base on smooth substrates to ensure a smooth installed appearance.

3.06 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

3.07 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 09 65 00

SECTION 09 68 13
TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Carpet tile, fully adhered.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 03 30 00 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors to receive adhesive-applied flooring.
- C. Section 03 54 00 - Cast Underlayment.
- D. Section 09 05 61 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.
- E. Section 09 6500 - Resilient Flooring

1.03 REFERENCE STANDARDS

- A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2023.
- C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- D. CRI 104 - Standard for Installation of Commercial Carpet; 2015.
- E. CRI 105 - Standard for Installation of Residential Carpet; 2015.
- F. CRI (GLP) - Green Label Plus Testing Program - Certified Products; Current Edition.
- G. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Operation and Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing carpet tile with minimum 5 years documented experience.. The following are pre-approved for installation of materials listed herein:

1.06 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Tile Carpeting:
 - 1. Tarkett; <https://commercial.tarkett.com/>
- B. Milliken & Company: www.milliken.com/#sle.

2.02 MATERIALS

- A. Tile Carpeting, Type C10B: TUFTED PATTERNED LOOP, manufactured in one color dye lot.
 - 1. Tile Size: 18 by 18 inch, nominal.
 - 2. Yarn Type: Dynex SD® Nylon (Stain resist)
 - 3. Refer to Finish Legend in drawings for color.
 - 4. Primary Backing Material: Synthetic
 - 5. Installation: Monolithic
- B. Tile Carpeting, Type C4A. Tufted, Tip Shear. manufactured in one color dye lot.
 - 1. Tile Size: 19.7" x 19.7"
 - 2. Yarn Type: Solution Dyed Nylon
 - 3. Primary Backing Material: PVC-Free WellBAC® Comfort Cushion, Traction back
 - 4. Installation: Monolithic
 - 5. Refer to Finish Legend in drawings for color.
- C. Tile Carpeting, Type C3, Walk off Carpet tile, Ethos.
 - 1. Tile Size: 18" x 18"
 - 2. Yarn Type: TDX® Nylon
 - 3. Primary Backing material: Ethos Modular Synthetic non-woven
 - 4. Installation: Monolithic
 - 5. Refer to Finish Legend in drawings for color.

2.03 ACCESSORIES

PART 3 EXECUTION

3.01 ENVIRONMENTAL REQUIREMENTS

- A. Do not install carpeting until wet construction work is completed.
- B. General Contractor shall maintain room conditions as follows:
 - 1. Relative Humidity: between 30 and 50 percent
 - 2. Room Temperature: minimum of 65 degrees F.
- C. Maintain specified environmental conditions for a minimum of 48 hours prior to startup of installation, and throughout installation period of carpet, until substantial completion of the project and acceptance by owner.

3.02 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet tile.
- C. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.
- D. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
 - 1. Test in accordance with Section 09 05 61.
 - 2. Test in accordance with ASTM F710.

3. Conduct tests by an independent testing agency acceptable to Owner.
 4. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.
- E. Verify that required floor-mounted utilities are in correct location.

3.03 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.
- C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
- D. Vacuum clean substrate.

3.04 INSTALLATION

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Frayed edges are not acceptable. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Locate change of color or pattern between rooms under door centerline.
- F. Adhere carpet tile to substrate along centerline of rooms, at perimeter of rooms, where tiles are cut, and at 15 foot intervals throughout rooms. Lay remainder of tile dry over substrate.
- G. Trim carpet tile neatly at walls and around interruptions.
- H. Complete installation of edge strips, concealing exposed edges.

3.05 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION 09 68 13

SECTION 09 90 00
PAINTING AND COATING - HEALTHCARE FACILITY GUIDE SPECIFICATION - SHERWIN-
WILLIAMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Interior painting and coating systems.

1.02 RELATED REQUIREMENTS

- A. Section 06 41 00 - Architectural Wood Casework - Hospital Grade
- B. Division 08 - Openings
- C. Division 22 - Plumbing
- D. Division 23 - Heating, Ventilating and Air Conditioning
- E. Division 26 - Electrical

1.03 REFERENCE STANDARDS

- A. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- B. SSPC-SP 2 - Hand Tool Cleaning; 2018.
- C. SSPC-SP 13 - Surface Preparation of Concrete; 2018.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Product characteristics.
 - 2. Surface preparation instructions and recommendations.
 - 3. Primer requirements and finish specification.
 - 4. Storage and handling requirements and recommendations.
 - 5. Application methods.
 - 6. Clean-up information.
- C. Applicator's qualification statement.
- D. Maintenance Data: Submit coating maintenance manual including finish schedule showing where each product/color/finish was used, product technical data sheets, safety data sheets (SDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Extra Paint and Finish Materials: 1 gallon of each color; from the same product run, store where directed.
 - 3. Label each container with color in addition to manufacturer's label.

1.05 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 3 years experience and approved by manufacturer.

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Facility Guide Specification -
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09 90 00 - 1

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, product name, product code, color designation, VOC content, batch date, environmental handling, surface preparation, application, and use instructions.
- C. Paint Materials: Store at a minimum of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.
- D. Handling: Maintain a clean, dry storage area to prevent contamination or damage to materials.

1.07 FIELD CONDITIONS

- A. Do not apply materials when environmental conditions are outside the ranges required by manufacturer.
- B. Follow manufacturer's recommended procedures for producing the best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design Products: Subject to compliance with requirements, provide Sherwin-Williams Company (The) products indicated; www.sherwin-williams.com/#sle.

2.02 PAINTINGS AND COATINGS

- A. General:
 - 1. Provide factory-mixed coatings unless otherwise indicated.
 - 2. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application.
 - 3. Do not reduce, thin, or dilute coatings or add materials to coatings unless specifically indicated in manufacturer's instructions.
- B. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

2.03 PAINT SYSTEMS - INTERIOR

- A. Metal: Aluminum and galvanized.
 - 1. Epoxy Systems, Water Based:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series: www.sherwin-williams.com/#sle.
(a) 5 mils wet, 2 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, K46 Series: www.sherwin-williams.com/#sle.
(a) 4 mils wet, 1.5 mils dry per coat.
- B. Drywall: Walls, ceilings, gypsum board, and similar items.
 - 1. Latex Systems:
 - a. Eg-Shel Finish Formaldehyde and Odor Reducing:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams SuperPaint Air Purifying Technology, Satin, A87 Series: www.sherwin-williams.com/#sle.
 - b. Flat Finish Formaldehyde and Odor Reducing:

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- 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
- 2) 2nd and 3rd Coat: Sherwin-Williams SuperPaint Air Purifying Technology, Flat, A86 Series: www.sherwin-williams.com/#sle.
2. Epoxy Systems, Water Based:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - (a) 4 mils wet, 1.5 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, K46 Series: www.sherwin-williams.com/#sle.
 - (a) 4 mils wet, 1.5 mils dry per coat.
 - b. Eg-Shel/Low Luster Finish:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - (a) 4 mils wet, 1.5 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, K45 Series: www.sherwin-williams.com/#sle.
 - (a) 4 mils wet, 1.5 mils dry per coat.
- C. Concrete: Floors, non-vehicular.
 1. Latex Systems:
 - a. Semi-Gloss Finish:
 - 1) 1st and 2nd Coat: Sherwin-Williams Tread-Plex Acrylic Floor Coating, B90 Series: www.sherwin-williams.com/#sle.
 - (a) 3.5 mils wet, 1.5 mils dry per coat.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. Test shop-applied primer for compatibility with subsequent cover materials.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove mildew from impervious surfaces by scrubbing with solution of water and bleach. Rinse with clean water and allow surface to dry.
- D. Concrete:
 1. Remove release agents, curing compounds, efflorescence, and chalk.
 2. Fill bug holes, air pockets, and other voids with cement patching compound.
 3. Prepare concrete according to SSPC-SP 13.
- E. Masonry: Remove efflorescence and chalk.
- F. Cementitious Siding: Remove dirt, dust and other foreign matter. Pressure clean, if needed, to remove grease, oil, and loose particles.

- G. Gypsum Board: Fill minor defects with filler compound; sand smooth and remove dust prior to painting.
- H. Plaster: Fill hairline cracks, small holes, and imperfections with patching plaster. Make smooth and flush with adjacent surfaces. Treat textured, soft, porous, or powdery surfaces in accordance with manufacturer's instructions.
- I. Concrete Floors and Traffic Surfaces: Prepare concrete according to SSPC-SP 13.
- J. Aluminum: Remove surface contamination and oil; wash with solvent according to SSPC-SP 1.
- K. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 - 2. Prepare surface according to SSPC-SP 2.
- L. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Prime bare steel surfaces.
 - 3. Remove rust, loose mill scale, and other foreign substances using methods recommended by paint manufacturer and blast cleaning according to SSPC-SP 6. Protect from corrosion until coated.
- M. Wood: Remove dust, grit, and foreign matter. Scrape, sand, and spot prime knots and pitch streaks. Fill nail holes and imperfections with wood filler and sand smooth.

3.03 APPLICATION

- A. Reference finish schedule and color schedule key for color selections.
- B. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- C. Paint all HVAC grilles, ceiling access panels, electrical panel covers, speaker covers, fire extinguisher cabinets, countertop support brackets, coiling doors and frames, and any other miscellaneous items. Paint to match adjacent surface.
- D. Paint both sides of all new and existing hollow metal window frames, vision panels, door frames, elevator doors and frames, hollow metal doors.
- E. Apply products in accordance with manufacturer's written instructions.
- F. Apply coatings at spread rate required to achieve manufacturer's recommended dry film thickness.
- G. Regardless of number of coats specified, apply additional coats until complete hide is achieved.

3.04 PRIMING

- A. Apply primer to all surfaces unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.
- B. Primers specified in painting schedules may be omitted on factory primed or factory finished items, if acceptable to top coat manufacturers.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Clean surfaces immediately of overspray, splatter, and excess material.
- C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.06 PROTECTION

- A. Protect finished coatings from damage until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 90 00

SECTION 10 21 16
CULTURED MARBLE TUB AND SHOWER COMPARTMENTS

PART 1 - GENERAL

A. CULTURED MARBLE SHOWER SURROUNDS

B. SHOWER RECEPTORS

3.01 REFERENCE STANDARDS

- A. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- B. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.
- C.
- D. SUBMITTALS
 - a. Product Data: For each type of product.
 - 1) Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - b. Shop Drawings: For shower and dressing compartments.
 - 1) Include plans, elevations, sections, and attachment details.
 - 2) Show locations of cutouts for compartment-mounted accessories.
 - 3) Show locations of centerlines of drains.
 - c. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
 - 1) Each type of material, color, and finish required for compartments, prepared on 6-inch- square Samples of same thickness and material indicated for the Work.

PART 2 - PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 75 or less.
 - 2) Smoke-Developed Index: 450 or less.
- 2. Accessibility Standard: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for shower and dressing compartments designated as accessible.
- B. CULTURED MARBLE SHOWER SURROUNDS
 - 1. MANUFACTURER
 - a. Basis of Design: Superior Home Products
 - b. Subject to compliance with requirements, provide product indicated in the 'Finish Legend' on the drawings or an APPROVED comparable product.
 - 1) Color: As indicated in the Finish Legend on the drawings.
- C. SHOWER RECEPTORS
 - 1. MANUFACTURER
 - a. Basis of Design: Inpro Prisim Solid Surface Standard ADA Shower Receptor
 - b. Color: As indicated in the Finish Legend on the drawings.
 - c. Type: ADA Transfer Shower Receptor
 - d. Size: 37 9/16" x 36 3/4" (36" x 36" Finished).
 - e. Drain Location: Center Drain

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CULTURED MARBLE TUB AND
SHOWER COMPARTMENTS

10 21 16 - 1

- f. Threshold: Integral ADA compliant threshold
- g. Shower Drain: Shall be Oatey number 42150, Brass, No-caulk, Drain w/Brass or Polished Stainless Steel Strainer. Drain body is sealed to shower base with a fiber and rubber washer. Drain is secured to 2", 40 DWV pipe with a mechanically compressed gasket that does not require caulking. Drain top to accommodate 4 1/4" Universal Snap-Tite Strainer.

PART 3 - EXECUTION

5.01 EXAMINATION

- A. Examine areas and conditions in which shower receptors will be installed.

5.02 PREPARATION

- A. Surface Prep: Prior to installation, clean the substrate to remove dust, debris and loose particles. Ensure the substrate is sound and per project plans.
- B. Acclimate product in temperatures between 65°F and 80°F [18°-27°C] and a humidity level less than 80% 24 hours in advance of installation
- C. The area of installation must temperature and humidity controlled for at least 48 hours after installation.

5.03 INSTALLATION

- A. General: Install components plumb and level, scribe adjacent finishes, in accordance with approved shop drawings and recommended installation instructions.

5.04 CLEANING

- A. At completion of the installation, clean surfaces in accordance with the manufacturer clean-up and maintenance instructions.

END OF SECTION 10 21 16

**SECTION 10 21 23
CUBICLE CURTAINS AND TRACK**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface mounted overhead curtain track and guides.
- B. Cubicle curtains.

1.02 RELATED REQUIREMENTS

- A. Section 09 51 00 - Acoustical Ceilings: Suspended ceiling system to support track.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- B. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films; 2023, with Errata.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for curtain fabric characteristics.
- C. Shop Drawings: Indicate a reflected ceiling plan view of curtain track, hangers and suspension points, attachment details, schedule of curtain sizes.
- D. Samples: Submit two fabric samples, 6 by 6 inch in size illustrating fabric color.
- E. Maintenance Data: Include recommended cleaning methods and materials and stain removal methods.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Curtains: Two of each type and size.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Cubicle Track and Curtains:
 - 1. Construction Specialties, Inc; Track Systems: www.c-sgroup.com/#sle.
 - 2. Inpro: www.inprocorp.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 TRACKS AND TRACK COMPONENTS

- A. Tracks: Extruded aluminum sections; one piece per track run.
 - 1. Profile: Channel.
 - 2. Mounting: Surface.
 - 3. Structural Performance: Capable of supporting vertical test load of 50 lbs without visible deflection of track or damage to supports, safely supporting moving loads, and sufficiently rigid to resist visible deflection and without permanent set.
 - 4. Track End Stop: To fit track section.
 - 5. Track Bends: Minimum 12 inch radius; fabricated without deformation of track section or impeding movement of carriers.
 - 6. Finish on Exposed Surfaces: White enamel.
- B. Curtain Carriers: Nylon rollers, size and type compatible with track; designed to eliminate bind when curtain is pulled; fitted to curtain to prevent accidental curtain removal.

- C. Wand: Plastic, attached to lead carrier, for pull-to-close action.
- D. Installation Accessories: Types required for specified mounting method and substrate conditions.

2.03 CURTAINS

- A. Cubicle Curtains:
 - 1. Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - 2. Inherently flame resistant or flameproofed; capable of passing NFPA 701 test.
 - 3. Material: Close weave polyester; anti-bacterial, self deodorizing, sanitized, and preshrunk.
 - 4. Color/Pattern: Reference Color Schedule Key in drawings..
 - 5. Open Mesh Cloth: Open weave to permit air circulation; flameproof material, manufacturer's standard color.
 - 6. Attachment of Curtain Fabric to Open Mesh Cloth: Snap fasteners.
- B. Curtain Fabrication:
 - 1. Width of curtain to be 10 percent wider than track length.
 - 2. Curtains to be manufactured in sections of 8' for easy interchange.
 - 3. Length of curtain to end 15 inches above finished floor.
 - 4. Direction of pattern as indicated in drawings.
 - 5. Include open mesh cloth at top 22 inches of curtain for room air circulation, attached to curtain as specified above.
 - 6. Seams and Hems: Manufacturer's standard fabrication method for securely sewn and finished seams and hems.
 - 7. Provide attic stock of 4 curtains, standard length.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and supports above ceiling are ready to receive work of this Section.
- B. Verify that field measurements are as indicated.

3.02 INSTALLATION

- A. Install curtain track to be secure, rigid, and true to ceiling line.
- B. Secure track to ceiling system.
- C. Install end cap and stop device.
- D. Install curtains on carriers ensuring smooth operation.

END OF SECTION 10 21 23

**SECTION 10 26 00
WALL AND DOOR PROTECTION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Corner guards.
- B. Protective wall covering.

1.02 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications: Corner guards fabricated from rolled metal sections or bent plate.
- B. Section 05 50 00 - Metal Fabrications: Anchors for attachment of work of this section, concealed in wall.
- C. Section 08 71 00 - Door Hardware: Standard protection plates and trim.
- D. Section 09 21 16 - Gypsum Board Assemblies: Placement of supports in stud wall construction.
- E. Section 09 22 16 - Non-Structural Metal Framing: Placement of supports in stud wall construction.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2023, with Editorial Revision.
- C. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents; 2021.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- E. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- F. ASTM F476 - Standard Test Methods for Security of Swinging Door Assemblies; 2023.
- G. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.
- C. Shop Drawings: Include plans, elevation, sections, and attachment details. Show design and spacing of supports for protective corridor handrails, required to withstand structural loads.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
- E. Maintenance Data: Manufacturer's instructions for care and cleaning of each type of product. Include information about both recommended and potentially detrimental cleaning materials and methods.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wall and door protection items in original, undamaged protective packaging. Label items to designate installation locations.

- B. Protect work from moisture damage.
- C. Do not deliver products to project site until areas for storage and installation are fully enclosed, and interior temperature and humidity are in compliance with manufacturer's recommendations for each type of item.
- D. Store products in either horizontal or vertical position, in compliance with manufacturer's instructions.

1.06 WARRANTY

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Corner Guards:
 - 1. Inpro: www.inprocorp.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Protective Wall Covering:
 - 1. Inpro: www.inprocorp.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PERFORMANCE CRITERIA

- A. Impact Strength: Unless otherwise noted, provide protection products and assemblies that have been successfully tested for compliance with applicable provisions of ASTM D256 and/or ASTM F476.

2.03 PRODUCT TYPES

- A. Corner Guards, End Wall Guards, Angle Guards-Surface Mounted:
 - 1. Material: Polyethylene terephthalate (PET or PETG); PVC-free.
 - 2. Vinyl: Corner guard of .080" (2mm) thickness shall be made from chemical and stain-resistant unplasticized polyvinyl chloride (uPVC) with the addition of impact modifiers. No plasticizers shall be added (plasticizers may aid in bacterial growth).
 - 3. Fasteners: Tape: Factory applied double faced foam tape
 - 4. Reference Finish Legend in drawings for model number, size and color.
- B. Protective Wall Covering-Rigid:
 - 1. Material: High-impact acrylic-modified vinyl.
 - 2. Thickness: 0.040 inch.
 - 3. Color: As indicated on drawings.
 - 4. Pattern: None.
 - 5. Texture: Velvet.
 - 6. Accessories: Provide manufacturer's standard color-matched trim and moldings.
 - a. Inside Corner Trim: Standard angle
 - b. Outside Corner Trim: Standard angle.
 - c. Top Trim: Standard J Trim
 - 7. Mounting: Adhesive.
- C. Adhesives and Primers: As recommended by manufacturer.
- D. Mounting Brackets and Attachment Hardware: Appropriate to component and substrate.

2.04 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.
- C. Form end trim closure by capping and finishing smooth.

2.05 SOURCE QUALITY CONTROL

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

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that field measurements are as indicated on drawings.
- C. Verify that substrate surfaces for adhered items are clean and smooth.
 - 1. Test painted or wall covering surfaces for adhesion in inconspicuous area, as recommended by manufacturer. Follow adhesive manufacturer's recommendations for remedial measures at locations and/or application conditions where adhesion test's results are unsatisfactory.
- D. Start of installation constitutes acceptance of project conditions.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.

3.03 TOLERANCES

- A. Maximum Variation From Required Height: 1/4 inch.
- B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch.

3.04 CLEANING

- A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
- B. Clean wall and door protection items of excess adhesive, dust, dirt, and other contaminants.

END OF SECTION 10 26 00

**SECTION 10 44 00
FIRE PROTECTION SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire extinguisher cabinets.
- B. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

1.03 REFERENCE STANDARDS

- A. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide extinguisher operational features.
- C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Extinguishers:
 - 1. Activar Construction Products Group, Inc. - JL Industries; Cosmic Extinguisher - Multipurpose Chemical: www.activarcpg.com/#sle.
 - 2. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fire Extinguisher Cabinets and Accessories:
 - 1. Activar Construction Products Group - JL Industries: www.activarcpg.com/#sle.
 - 2. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
 - 3. Larsen's Manufacturing Co: www.larsensmfg.com/#sle.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Size: 10 pound.
 - 3. Finish: Baked polyester powder coat, ____ color.

2.03 FIRE EXTINGUISHER CABINETS

- A. Cabinet Construction: Non-fire rated.
 - 1. Formed primed steel sheet; 0.036 inch thick base metal.
- B. Cabinet Configuration: Semi-recessed type.
- C. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- D. Door Glazing: Float glass, clear, 1/8 inch thick, and set in resilient channel glazing gasket.
- E. Finish of Cabinet Exterior Trim and Door: Baked enamel, color as selected.
- F. Finish of Cabinet Interior: White colored enamel.

2.04 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, chrome-plated.
- B. Lettering: "FIRE EXTINGUISHER" decal, or vinyl self-adhering, prespaced black lettering in accordance with authorities having jurisdiction (AHJ).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Place extinguishers in cabinets.

3.03 MAINTENANCE

- A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

END OF SECTION 10 44 00

**SECTION 12 24 00
WINDOW SHADES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior manual roller shades.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Concealed wood blocking for attachment of headrail brackets.
- B. Section 26 27 26 - Wiring Devices: Finish requirements for wall controls specified in this section.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week prior to commencing work related to products of this section; require attendance of affected installers.
- B. Sequencing:
 - 1. Do not fabricate shades until field dimensions for each opening have been taken with field conditions in place.
 - 2. Do not install shades until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
- B. Shop Drawings: Include shade schedule indicating size, location and keys to details, head, jamb and sill details, mounting dimension requirements for each product and condition, and operation direction.
- C. Certificates: Manufacturer's documentation that line voltage components are UL listed or UL recognized.
- D. Source Quality Control Submittals: Provide test reports indicating compliance with specified fabric properties.
- E. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of shop drawings.
- G. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of this type with minimum 5 years of documented experience with shading systems of similar size and type.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.
- B. Handle and store shades in accordance with manufacturer's recommendations.

1.08 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.09 WARRANTY

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Interior Manually Operated Roller Shades:
 - 1. MechoShade Systems LLC; Mecho/7 System: www.mechoshade.com/#sle.
- B. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 ROLLER SHADES

- A. General:
 - 1. Provide shade system components that are easy to remove or adjust without removal of mounted shade brackets.
 - 2. Provide shade system that operates smoothly when shades are raised or lowered.
 - 3. Motorized Shades: Motor system housed inside roller tube, controlling shade movement via motor controls indicated; listed or recognized to UL 325.
 - a. Comply with NFPA 70.
 - b. Electrical Components: Listed, classified, and labeled as suitable for the purpose intended. Where applicable, system components to be FCC compliant.
 - c. Motors: Size and configuration as recommended by manufacturer for the type, size, and arrangement of shades to be operated; integrated into shade operating components and concealed from view; fully compatible with controls to be installed.
- B. Roller Shades Type SC1A:
 - 1. Description - Interior Roller Shades: Double roller, manually operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and accessories.
 - a. Drop Position: Regular roll.
 - b. Mounting: Window jamb mounted - outside, on face of jambs.
 - c. Fabric: As indicated in Finish Legend
 - 2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 - a. Double Roller Brackets: Configured for light-filtering and room-darkening shades in one opening.
 - 3. Roller Tubes: As required for type of shade operation.
 - 4. Hembars: Designed to maintain bottom of shade straight and flat.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine finished openings for deficiencies that may preclude satisfactory installation.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

- C. Start of installation shall be considered acceptance of substrates.

3.02 PREPARATION

- A. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.
- B. Coordinate with window installation and placement of concealed blocking to support shades.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.
- B. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.04 SYSTEM STARTUP

- A. Motorized Shade System: Provide services of a manufacturer's authorized representative to perform system startup.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate operation and maintenance of window shade system to Owner's personnel.

3.06 PROTECTION

- A. Protect installed products from subsequent construction operations.
- B. Touch-up, repair, or replace damaged products before Substantial Completion.

3.07 MAINTENANCE

- A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

END OF SECTION 12 24 00

TABLE OF CONTENTS

DIVISION 21 - FIRE SUPPRESSION

SECTION 210500 - BASIC FIRE SUPPRESSION REQUIREMENTS
SECTION 210505 - FIRE SUPPRESSION DEMOLITION FOR REMODELING
SECTION 210529 - FIRE SUPPRESSION SUPPORTS AND ANCHORS
SECTION 210550 - SEISMIC REQUIREMENTS FOR EQUIPMENT AND SUPPORTS
SECTION 210553 - FIRE SUPPRESSION IDENTIFICATION
SECTION 211302 - FIRE PROTECTION PERFORMANCE BASED DESIGN

DIVISION 22 - PLUMBING

SECTION 220500 - BASIC PLUMBING REQUIREMENTS
SECTION 220505 - PLUMBING DEMOLITION FOR REMODELING
SECTION 220529 - PLUMBING SUPPORTS AND ANCHORS
SECTION 220553 - PLUMBING IDENTIFICATION
SECTION 220719 - PLUMBING PIPING INSULATION
SECTION 220800 - COMMISSIONING OF PLUMBING
SECTION 221000 - PLUMBING PIPING
SECTION 221030 - PLUMBING SPECIALTIES

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING(HVAC)

SECTION 230500 - BASIC HVAC REQUIREMENTS
SECTION 230505 - HVAC DEMOLITION FOR REMODELING
SECTION 230513 - MOTORS
SECTION 230529 - HVAC SUPPORTS AND ANCHORS
SECTION 230550 - SEISMIC REQUIREMENTS FOR EQUIPMENT AND SUPPORTS
SECTION 230553 - HVAC IDENTIFICATION
SECTION 230593 - TESTING, ADJUSTING, AND BALANCING
SECTION 230713 - DUCTWORK INSULATION
SECTION 230719 - HVAC PIPING INSULATION
SECTION 230800 - COMMISSIONING OF HVAC
SECTION 230900 - CONTROLS
SECTION 230913 - INSTRUMENTATION
SECTION 230920 - VENTURI VALVE AIRFLOW CONTROL SYSTEM
SECTION 232100 - HYDRONIC PIPING
SECTION 232116 - HYDRONIC SPECIALTIES
SECTION 232123 - HVAC PUMPS
SECTION 233100 - DUCTWORK
SECTION 233300 - DUCTWORK ACCESSORIES
SECTION 233416 - CENTRIFUGAL FANS
SECTION 233600 - AIR TERMINAL UNITS
SECTION 233700 - AIR INLETS AND OUTLETS
SECTION 237200 - ENERGY RECOVERY DEVICES
SECTION 237413 - ROOFTOP MODULAR AIR HANDLING UNITS
SECTION 238200 - TERMINAL HEAT TRANSFER UNITS
SECTION 238216 - AIR COILS
SECTION 238413 - HUMIDIFIERS

DIVISION 26 - ELECTRICAL

SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS
SECTION 260505 - ELECTRICAL DEMOLITION FOR REMODELING
SECTION 260513 - WIRE AND CABLE
SECTION 260526 - GROUNDING AND BONDING
SECTION 260527 - SUPPORTING DEVICES
SECTION 260533 - CONDUIT AND BOXES
SECTION 260535 - SURFACE RACEWAYS
SECTION 260548 - SEISMIC REQUIREMENTS FOR EQUIPMENT AND SUPPORTS
SECTION 260553 - ELECTRICAL IDENTIFICATION
SECTION 260801 - COMMISSIONING OF ELECTRICAL
SECTION 260933 - LIGHTING CONTROL SYSTEMS
SECTION 262419 - MOTOR CONTROL
SECTION 262726 - WIRING DEVICES
SECTION 262816 - DISCONNECT SWITCHES
SECTION 262923 - VARIABLE FREQUENCY DRIVES
SECTION 265119 - LED LIGHTING

DIVISION 27 - COMMUNICATIONS

SECTION 270500 - BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS
SECTION 270503 - THROUGH PENETRATION FIRESTOPPING
SECTION 270505 - TECHNOLOGY DEMOLITION FOR REMODELING
SECTION 270528 - INTERIOR COMMUNICATION PATHWAYS
SECTION 270553 - IDENTIFICATION FOR COMMUNICATION SYSTEMS
SECTION 271100 - COMMUNICATION EQUIPMENT ROOMS (CER)
SECTION 271300 - BACKBONE CABLING REQUIREMENTS
SECTION 271500 - HORIZONTAL CABLING REQUIREMENTS
SECTION 271710 - TESTING

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 280500 - BASIC ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS
SECTION 281300 - ELECTRONIC ACCESS CONTROL
SECTION 283100 - FIRE ALARM AND DETECTION SYSTEMS

SECTION 210500 - BASIC FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 21 Sections. Also refer to Division 01 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours will be required.
- B. Itemize all work and list associated hours and pay scale for each item.

1.3 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
 - a. Plumbing Contractor.
 - b. Heating Contractor.
 - c. Air Conditioning and Ventilating Contractor.
 - d. Temperature Control Contractor.
 - e. Fire Protection Contractor.
 - f. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.

5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
 - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.

5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
 - a. Light fixtures.
 - b. Gravity flow piping, including steam and condensate.
 - c. Electrical busduct.
 - d. Sheet metal.
 - e. Electrical cable trays, including access space.
 - f. Sprinkler piping and other piping.
 - g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
 - a. Fire Pump.
 - b. Jockey Pump.
 - c. Fire Control Panels.
2. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
3. Wiring of all devices needed to make the fire protection systems functional, for example: pump control wiring, sensor wiring, pre-action device wiring, and clean agent system wiring, unless control wiring is part of the fire alarm scope. Fire Protection Contractor shall verify any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for a complete system, but not shown on the electrical drawings, is the responsibility of the Fire Protection Contractor.

D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor when so noted on the Electrical Drawings.
3. Provides motor control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.4 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
 - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.

- a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
 3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
 2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
 3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
 4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect/Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.
- D. General:
1. Coordination drawing files shall be made available to the Architect/Engineer and Owner's Representative. The Architect/Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.
 2. A plotted set of coordination drawings shall be available at the project site.
 3. Coordination drawings are not shop drawings and shall not be submitted as such.
 4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
 5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The Architect/Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect/Engineer.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the Architect/Engineer at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect/Engineer and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.5 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Rogers, AR Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all published standards of Mercy Health.
3. Conform to all State Codes.
4. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
6. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
7. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
8. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriters' Laboratories, Inc. and approved by FM Global.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. Make application for and pay for fire protection water service connection.

F. Examination of Drawings:

1. The drawings for the fire protection work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in fire protection documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 - a. Any item listed as furnished shall also be installed, unless otherwise noted.
 - b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.6 WEB-BASED PROJECT SOFTWARE

- A. The General Contractor shall provide a web-based project software site for the purpose of hosting and managing project communication and documentation until completion of the warranty phase.
- B. The web-based project software shall include, at a minimum, the following features: construction schedule, submittals, RFIs, ASIs, construction change directives, change orders, drawing management, specification management, payment applications, contract modifications, meeting minutes, construction progress photos.
- C. Provide web-based project software user licenses for use by the Architect/Engineer. Access will be provided from the start of the project through the completion of the warranty phase.
- D. At project completion, provide digital archive of entire project in format that is readable by common desktop software applications in format acceptable to Architect/Engineer. Provide data in locked format to prevent further changes.

1.7 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
21 05 00	Owner Training Agenda
21 05 50	Seismic Restraint Systems
21 13 00	Sprinkler Systems
21 13 00	Fire Protection Equipment

- B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:

1. Transmittal: Each transmittal shall include the following:

- a. Date
- b. Project title and number
- c. Contractor's name and address
- d. Division of work (e.g., plumbing, heating, ventilating, etc.)
- e. Description of items submitted and relevant specification number

- f. Notations of deviations from the contract documents
 - g. Other pertinent data
- 2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
- 3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
- 4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
- 5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.

- 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
- d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
 8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
 9. Reproduction of contract documents alone is not acceptable for submittals.
 10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
 11. Submittals not required by the contract documents may be returned without review.
 12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
 13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
 14. Contractor's responsibility for errors, omissions, or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 21 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 21 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.8 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 01.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.

2. Break down all costs into:
 - a. Material: Delivered cost of product with taxes paid.
 - b. Labor: Labor cost, excluding overhead and profit.
 3. Itemize the cost for each of the following:
 - a. Overhead and profit.
 - b. Bonds.
 - c. Insurance.
 - d. General Requirements: Itemize all requirements.
 4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
 - a. Each piece of equipment requiring shop drawings (e.g., fire pump, double interlock pre-action system, backflow preventer, etc.) using the project nomenclature (FP-1, DIPS-1, BFP-1, etc.).
 - b. Each sprinkler zone. In addition, break down the material and labor based on geography (building, floor, wing and/or phase).
 - c. Each double interlock pre-action system.
 - d. Each clean agent fire suppression system.
 - e. Each wet agent fire suppression system.
 - f. Site utilities (5' beyond building)
 - g. Seismic design
 - h. Commissioning
 - i. Record drawings
 - j. Punchlist and closeout
- D. Update Schedule of Values when:
1. Indicated by Architect/Engineer.
 2. Change of subcontractor or supplier occurs.
 3. Change of product or equipment occurs.

1.9 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
 - 1. Fire Seal Systems
 - 2. Vibration Isolation
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Protect equipment, components, and openings with airtight covers and exercise care at every stage of storage, handling, and installation of equipment to prevent airborne dust and dirt from entering or fouling equipment to include, but not limited to:
 - 1. Motor windings and ventilation openings.
 - 2. Bearings.
 - 3. Equipment Pipe and Accessories connection openings.
 - 4. Starter and control cabinets.
 - 5. Pump Seals.
 - 6. Engine cooling, air intake, and exhaust openings.
- C. Equipment and components that are visibly damaged or have been subject to environmental conditions prior to building turnover to Owner that could shorten the life of the component (for example, water damage, humidity, dust and debris, excessive hot or cold storage location, etc.) shall be repaired or replaced with new equipment or components without additional cost to the building owner.
- D. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- E. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

- F. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.14 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.15 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.

- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

1.16 PROJECT COMMISSIONING

- A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 01 91 00 and 21 08 00 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (<https://call811.com/>) or by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment, or buried utilities. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. Utilities Bedding: Lay underground utilities on minimum of 6" sand bedding or CA6 crushed stone. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
2. Envelope Around Utilities to 6" Above Utilities: Place sand or CA6 crushed stone or flowable fill to a height of 6" over utilities in 6" layers. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
3. Backfill From 6" Above Utilities to Earthen Grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep.
4. Backfill From 6" Above Utilities to Below Slabs or Paved Area: Where the sand or CA6 crushed stone fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
5. Backfill Materials:
 - a. Sand, CA6: Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
 - b. Native Soil: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Native soils shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
 - c. Flowable Fill: Cementitious, self-leveling, self-compacting slurry as defined by the ACI with compressive strength of 50-100psi at 28 days; consisting of a mixture of fine aggregate or filler, water and cementitious materials. Filler material consist of sand, fly ash, spent foundry sand, quarry fines, baghouse dust. Cementitious materials consist of Portland cement, pozzolanic materials, and self-cementing materials. Flowable fill may be placed in a pour instead of 6" layers noted above.
6. Water shall not be permitted to rise in unbackfilled trenches.
7. Dispose of excess excavated earth as directed.
8. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
9. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
 - a. Pipe wall penetrations are sealed.
 - b. Pipe identification is installed.
 - c. Branch piping in the location of sprinklers shall be dropped to the ceiling.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 01.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.

3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up or reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Inspection report by the State Fire Marshal of the fire protection system.
5. Start-up reports on all equipment requiring a factory installation inspection or start-up.
6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div21.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div21.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- E. The instructions shall include:
 - 1. Explanation of all system flow diagrams.
 - 2. Maintenance of equipment.
 - 3. Start-up procedures for all major equipment.
 - 4. Explanation of seasonal system changes.
 - 5. Description of emergency system operation.
- F. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
- G. Minimum hours of instruction for each item shall be:
 - 1. Sprinkler System(s) - 2 hours.
- H. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of four weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
- I. Operating Instructions:
 - 1. Contractor is responsible for all instructions to the Owner's representatives for the fire protection and control systems.
 - 2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM STARTING AND ADJUSTING

- A. The fire protection systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 01 requirements.
- B. Maintain at the job site a separate and complete set of fire protection drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations of other control devices, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.
- D. Before completion of the project, a set of reproducible fire protection drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.

- F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.9 PAINTING

- A. This Contractor shall paint the following items:
 - 1. All piping in mechanical room
 - 2. Piping exposed in kitchen
- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.
- D. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.
- F. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- G. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.
- H. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter, paint all pipes and equipment with the following:
 - 1. Bare Metal Surfaces: Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
 - 2. Color of paint shall be as follows:
 - a. All piping in mechanical room:
 - 1) Fire Protection: Red pipe/white letters

b. Piping exposed in kitchen:

1) All Piping: White

3.10 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.11 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.12 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
 - 1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
 - a. Minimizing the amount of dust generated.
 - b. Reducing solvent fumes and VOC emissions.
 - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
 - 2. Request that the Owner designate an IAQ representative.
 - 3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
 - 4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.

5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
6. Request copies of and follow all of the Owner's IAQ and infection control policies.
7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All pumps operating and balanced.
3. Fire protection system operational.
4. Pipes labeled.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 210505 - FIRE SUPPRESSION DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Mechanical Demolition.
- B. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.
- B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.
- C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.
- D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.
- E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.
- F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.
- G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.2 PREPARATION

- A. Disconnect fire protection systems in walls, floors, and ceilings scheduled for removal.

- B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned piping to source of supply and/or main lines.
- C. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.
- D. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.
- E. Repair adjacent construction and finishes damaged during demolition and extension work.
- F. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.
- G. Extend existing installations using materials and methods compatible with existing installations, or as specified.

3.4 CUTTING AND PATCHING

- A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 210529 for additional requirements.
- B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.
- C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.
- D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.
- E. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to structural plans for additional information.
- F. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.5 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.
- C. FIRE PROTECTION ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.6 SPECIAL REQUIREMENTS

- A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.
- B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION

SECTION 210529 - FIRE SUPPRESSION SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

1.2 QUALITY ASSURANCE

- A. Support Sprinkler and Standpipe Piping in conformance with NFPA 13.
- B. All components shall be UL [and FM] listed and approved for fire protection systems.

1.3 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

- A. Refer to Section 210550 for additional requirements for seismic restraints.

2.2 HANGER RODS

- A. Hanger rods for single rod hangers supporting steel, copper, and CPVC piping shall conform to the following:
 - 1. Hanger Rod Diameter:
 - a. 4" and smaller: 3/8"
 - b. 5", 6", and 8": 1/2"
 - c. 10" and 12": 5/8"
 - d. 12": 3/4"
- B. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.3 PIPE HANGERS AND SUPPORTS

A. General:

1. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58, 69, 89, and 127 (where applicable).

B. Hangers and Clamps:

1. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp.
2. Unless otherwise indicated, hangers shall be as follows:
 - a. Clevis Type: Service: Bare Metal Pipe, Rigid Plastic Pipe
 - 1) Products: Bare Steel, Plastic or Insulated Pipe
 - a) Anvil Fig. 260
 - b) Eaton Fig. 3100
 - c) nVent Model 400
 - b. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller
 - 1) Products: Bare Steel Pipe
 - a) Anvil Fig. 69
 - b) Eaton Fig. B3170NF
 - c) nVent Model 115
 - 2) Products: Bare Copper Pipe
 - a) Eaton Fig. B3170CTC
 - b) Anvil Fig. CT-69
 3. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping.
 4. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
 5. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

6. Unless otherwise indicated, pipe supports for use with struts shall be as follows:

a. Clamp Type: Service: Bare Metal Pipe, Rigid Plastic Pipe

- 1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp.
- 2) Pipes subject to expansion and contraction shall have clamps slightly oversized to allow limited pipe movement.
- 3) Products: Bare Steel, Plastic or Insulated Pipe
 - a) Unistrut Fig. P1100 or P2500

C. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.)

- 1) Products:
 - a) Anvil Fig. 86/92/93
 - b) Eaton Fig. B3033/B3034
 - c) nVent Model 300/310/315

b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):

- 1) Products:
 - a) Anvil Fig. 218
 - b) Eaton Fig. B3054 (UL listed only, not FM)

c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):

- 1) Products:
 - a) nVent Model Truss-T Bar Joist Hanger (UL listed only, not FM)(UL listed only, not FM)
 - b) MCL Model M1, M2 or M3 (UL listed only, not FM)

d. Steel Structure Welding:

- e. Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and for protecting walls and ceilings from being damaged by smoke.

2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

Mode I	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40F to 250F
T	Fire Seals (1 hour)	Silicone	-67F to 400F
FS	Fire Seals (3 hours)	Silicone	-67F to 400F
OS	Oil Resistant/Stainless	Nitrile	-40F to 210F

2.5 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes duct and pipe openings.

2.6 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.7 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.8 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 FIRE SUPPRESSION SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.

2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
 3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
 4. Piping shall not introduce strains or distortion to connected equipment.
 5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
 6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
 7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
 8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.
- D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:
1. For attachments to joists that are concentrically loaded on the joist, a max of 100 pounds may be attached to the joist within a chord panel.
 2. For attachments to joists that are eccentrically loaded, a max of 25 lb may be attached to the joist within a chord panel without an additional angle.
 3. Multiple attachments are allowed in each chord panel as long as the sum of the loads do not exceed the max load indicated.
 4. For loads between 100 lb -200 lb, additional L2x2x3/16" (L51xL51x4.8) ASTM A36 structural steel angles are required and joist must be concentrically loaded.
 5. For loading conditions noted above, total sum of loads shall not exceed 200 lbs for an 8 ft segment of joist. For loads greater than 200 lbs and not noted on the drawings, contact engineer prior to installation/
 6. No loads shall be supported from joist bridging.
 7. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
 8. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Spacing of hangers shall in no case exceed the following:

1. Steel (All steel pipe unless otherwise noted):
 - a. Maximum Spacing:
 - 1) 1-1/4" & under: 12'-0"
 - 2) 1-1/2" & larger: 15'-0"
2. Steel (Schedule 40 lightweight alternative):
 - a. Maximum Spacing:
 - 1) 3" & under: 12'-0"
 - 2) 3" & under: 12'-0"
- I. Installation of hangers shall conform to MSS SP-58, 69, 89, and applicable NFPA standards.

END OF SECTION

SECTION 210550 - SEISMIC REQUIREMENTS FOR EQUIPMENT AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Seismic Requirements.

1.2 QUALITY ASSURANCE

A. General:

1. The contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint and support system and perform seismic calculations in accordance with these specifications, state, and local codes.
2. Items used for seismic restraint of equipment and systems shall be specifically manufactured for seismic restraint.
3. These requirements are beyond those listed in Section 210529 of these specifications. Where a conflict arises between the seismic requirements of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this Section.
2. Equipment: Each company providing equipment that must meet seismic requirements shall provide certification included in project submittals the equipment supplied for the project meets or exceeds the seismic requirements of the project.

- C. Testing Agency: An independent testing agency, acceptable to Authorities Having Jurisdiction, with experience and capability to conduct the testing indicated.

- D. Installer: Company specializing in performing the work of this Section.

1.3 REFERENCES

- A. Arkansas Building Code, 2021.
- B. ASHRAE - A Practical Guide to Seismic Restraint.
- C. Technical Manual 5-809-10, NAVFAC P-355, Air Force Manual 88-3, Chapter 13.
- D. ASCE 7-16, Chapter 13.
- E. SMACNA - Seismic Restraint Manual Guidelines for Mechanical Systems.
- F. NFPA 13 - Installation of Sprinkler Systems.
- G. NFPA 14 - Standpipe and Hose Systems.

1.4 SUBMITTALS

- A. Submit under provisions of Section 210500.
- B. Shop Drawings:
 - 1. Calculations, restraint selections, and installation details shall be designed and sealed by a Professional Engineer licensed in the state where the project is located experienced in seismic restraint design and installation.
 - 2. Coordination Drawings: Plans and sections drawn to scale, coordinating seismic bracing of mechanical components with other systems and equipment in the vicinity, including other seismic restraints.
 - 3. Manufacturer's Certifications: Professional Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
 - 4. System Supports/Restraints - Submit for each condition requiring seismic bracing:
 - a. Calculations for each seismic brace and detail utilized on the project.
 - b. Plan drawings showing locations and types of seismic braces on contractor fabrication/installation drawings.
 - c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
 - d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.
 - 5. Equipment - Submit for each piece of equipment supplied:
 - a. Certification that the equipment supplied for the project meets or exceeds the seismic requirements specified.
 - b. Specific details of seismic design features of equipment and maximum seismic loads imparted to the structural support.
 - c. Engineering calculations and details for equipment anchorage and support structure.
- C. A seismic restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If seismic restraints are not provided for a system that requires seismic bracing, the seismic designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, utilized for each item. Seismic designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance to the exception.

1.5 TESTING AND INSPECTION

- A. Special Inspection and Testing shall be done in accordance with Chapter 17 of the Building Code.

- B. The Owner shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.
- C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.
- D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

1.7 DESIGN REQUIREMENTS

- A. This project is subject to the seismic bracing requirements of the Arkansas Building Code, 2021 edition.
- B. The following criteria are applicable to this project:
 - 1. Risk Category: IV
 - 2. Seismic Importance Factor: $I_E = 1.5$ Seismic Design Category: D
 - 3. Component Amplification Factors (a_p) and Component Response Modification Factors (R_p) shall be taken from Table 13.5-1 in ASCE 7-16 for the individual equipment or system being restrained.
 - 4. Component Importance Factors (I_p) shall be taken from Section 13.1.3 in ASCE 7-16 for the individual equipment or system being restrained.
 - 5. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.
- C. Forces shall be calculated with the above requirements and Equation 13.3-1, -2, and -3 of ASCE 7-16, unless exempted by 13.1.4.
- D. Equipment shall meet Arkansas Building Code and ASCE 7 seismic qualification requirements in concurrence with ICC ES AC156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.
- E. All seismic anchorage and bracing shall comply with FM Global Property Loss Prevention Data Sheet 1-11, Fire Following Earthquakes.

1.8 COORDINATION

- A. Coordinate layout and installation of seismic bracing with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.
- B. Coordinate concrete bases with building structural system.

1.9 WARRANTY

- A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SUPPLIERS

- A. Following is a partial list of manufacturer/supplier contact information for seismic restraints:

- 1. B-Line Systems, Inc. (800) 851-7415, www.b-line.com.
- 2. Unistrut Corporation <http://www.unistrut.us/>
- 3. Kinetics Noise Control (877) 457-2695, www.kineticsnoise.com.
- 4. Mason Industries, Inc. www.mason-ind.com.
- 5. Loos & Co., Inc. (800) 321-5667, www.loosnaples.com.
- 6. Tolco (909) 737-5599, www.tolco.com
- 7. ISAT 877.523.6060, www.isatsb.com
- 8. Vibro-Acoustics (416) 291-7371, <https://virs.vibro-acoustics.com/>

2.2 SEISMIC DESIGN CRITERIA

- A. This section describes the requirements for seismic restraint of systems and equipment related to continued operation of the facility after a design seismic event.
- B. Definitions
 - 1. Stay in Place:
 - a. All systems and equipment shall be anchored and restrained such that the anchoring system is intended not to fail and equipment and/or system components will not fall.
 - 2. Remain Operational:
 - a. Requirements for "Stay in Place" listed above shall be met.
 - b. The following systems and associated equipment are intended not to fail externally or internally and are intended to continue operation following a seismic event:
 - 1) Fire Protection

2.3 SEISMIC BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Seismic restraint designer shall coordinate all attachments with the Structural Engineer of Record; refer to submittal requirements.
2. The seismic restraint design shall be based on actual equipment data obtained from manufacturer's submittals or the manufacturer. The equipment manufacturer shall verify and provide written certification the attachment points on the equipment can accept the combination of seismic, weight, and other imposed loads.
3. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
4. Analysis shall detail anchoring methods, bolt diameter, embedment, and weld length.
5. All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code.
6. All seismic restraints and combination isolator/restraints shall have verification of their seismic capabilities witnessed by an independent testing agency.

B. Friction from gravity loads shall not be considered resistance to seismic forces.

C. Fire protection systems shall meet the requirements of NFPA-13 and NFPA-14 for the building seismic requirements.

2.4 SEISMIC RESTRAINT AND CONSTRUCTION OF EQUIPMENT

A. Equipment supplied for the project shall be designed to meet the requirements of lateral forces calculated using the applicable code and method described above.

B. The following is a partial list of equipment that shall be restrained and that shall be constructed to meet seismic forces described in this section:

1. Fire Protection Equipment
2. Fire Pumps

2.5 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.
3. Corrosive Locations: Stainless steel.

2.6 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
- B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with IBC, ACI and ICC ES requirements for cracked concrete anchors.
- C. Concrete Inserts: Steel-channel type.
- D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125, Grade A 325.
- E. Welding Lugs: Comply with MSS SP-69, Type 57.
- F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.
- G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.7 SEISMIC BRACING COMPONENTS

- A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch-thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.
 1. Materials for Channel: ASTM A 1011, GR 33.
 2. Materials for Fittings and Accessories: ASTM A 635, ASTM A 576, or ASTM A 36.
 3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
 4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.
- B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.
- C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.
 1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
 2. Wire Rope Cable: Comply with ASTM A 603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.

- D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to the applicable code sections and Authority Having Jurisdiction for the exact seismic restraint requirements of piping, ductwork, conduit, equipment, etc.
- B. Layout of transverse and longitudinal bracing shall follow recommendations of approved design standards listed in Part 1 of this specification section.
- C. All rigid floor mounted equipment shall have a resilient media between the equipment mounting hole and the anchor bolt in concrete.
- D. All seismic restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
- E. Installation of seismic restraints shall not cause any change in position of equipment, piping, or ductwork, resulting in stresses or misalignment.
- F. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.
- G. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified.
- H. Coordinate work with all other trades to avoid rigid contact with the building. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Architect/Engineer's attention prior to specific equipment selection.
- I. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
- J. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or International Code Council approved seismic anchors for installation in concrete.
- K. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit.
- L. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.
- M. Do not install cables over sharp corners.
- N. Brace support rods when necessary to accept compressive loads. Welding of compression braces to the vertical support rods is not acceptable.

- O. Provide reinforced clevis bolts when required.
 - P. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.
 - Q. Post-Installed anchors shall be provided to meet seismic requirements.
 - R. Vertical pipe risers flexibly supported to accommodate thermal motion and/or pipe vibration shall be guided to maintain pipe stability and provide horizontal seismic restraint.
 - S. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.
 - T. Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent piping.
 - U. Water tanks shall be secured to their saddles by welding or proper concrete attachment, and those saddles shall be properly attached to the structure.
 - V. Brace all terminal units with water coils as required by the building code and provide flexible connection to the coil if bracing is required.
 - W. Independently brace duct mounted equipment (terminal units, in-line fans, etc.) and the associated suspended ductwork.
 - X. Do not brace a system to two different structures such as a wall and a ceiling.
 - Y. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.
 - Z. Positively attach all roof mounted equipment to roof curbs. Positively attach all roof curbs to building structure.
 - AA. Exposed seismic supports in occupied areas shall be guarded or covered to protect occupants.
 - BB. Coordinate seismic bracing of architecturally exposed ductwork with the Architect/Engineer.
- 3.2 SEISMIC RESTRAINT EXCLUSIONS
- A. Refer to the applicable code sections and Authority Having Jurisdiction for allowable exclusions.

END OF SECTION

SECTION 210553 - FIRE SUPPRESSION IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Identification of products installed under Division 21.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. 3M
- B. Bunting
- C. Calpico
- D. Craftmark
- E. Emedco
- F. Kolbi Industries
- G. Seton
- H. W.H. Brady
- I. Marking Services.

2.2 MATERIALS

- A. All pipe markers shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"
Plastic tags may be used for outside diameters under 3/4"		

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

- C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.
- H. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
 - 1. All valves (except shutoff valves at equipment) shall have numbered tags.
 - 2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
 - 3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
 - 4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
 - 5. Attach to handwheel or around valve stem.
 - 6. Number all tags and show the service of the pipe.
 - 7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
- D. Pipe Markers:
 - 1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
 - 2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
 - 3. Stencil Painted Pipe Markers:

- a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
 - b. Apply primer on non-insulated pipes before painting.
 - c. Use background and letter colors as scheduled later in this section.
4. Apply markers and arrows in the following locations where clearly visible:
- a. At each valve.
 - b. On both sides of walls that pipes penetrate.
 - c. At least every 20 feet along all pipes.
 - d. On each riser and each leg of each "T" joint.
 - e. At least once in every room and each story traversed.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

3.2 SCHEDULE

- A. Pipes to be marked shall be labeled with text shown as follows, regardless of which method or material is used:
1. FIRE PROTECTION WATER: White lettering; red background
 2. SPRINKLER WATER: White lettering; red background
- B. All piping downstream of the fire protection backflow preventer, upstream of sprinkler zone valves, standpipe piping, and combination sprinkler standpipe piping shall be labeled Fire Protection Water. All piping downstream of sprinkler zone valves shall be labeled Sprinkler Water.

END OF SECTION

SECTION 211302 - FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe, Fittings, Valves, and Connections for Fire Protection System.
- B. Wet-Pipe Sprinkler System.

1.2 QUALITY ASSURANCE

- A. Welding Materials and Procedures: Conform to ASME Code.
- B. Equipment and Components: Bear UL/FM label or marking.
- C. Valves: Bear UL/FM label or marking. Provide manufacturer's name and pressure rating marked on valve body. Pressure rating shall match specified pipe system pressure rating. Remanufactured valves are not acceptable.
- D. Specialist Firm: Company specializing in sprinkler systems with minimum three years' experience.
- E. Sprinkler design drawings submitted by the Contractor shall be prepared by a NICET Water-Based Fire Protection Systems Layout Level III or Level IV designer or PE.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 210500. Indicate pipe materials, joining methods, supports, floor and wall penetration seals, sprinklers, equipment data and ratings, and hydraulic calculations.
- B. Submit detailed pipe and sprinkler layout and other calculations and forms as described in NFPA 13.
- C. Submit detailed working drawings and obtain review of them in the following order:
 - 1. Engineer/Architect State Fire Marshal/Authority Having Jurisdiction
 - 2. Owner's Insurance Company
 - 3. Architect/Engineer
 - 4. Department of Health and Family Services (Hospitals, Nursing Homes, CBRF's only)
 - 5. Local Fire Department
 - 6. Owner's Insurance Company
 - 7. Architect/Engineer
- D. Working drawings shall include piping and sprinkler layout, sprinkler types and ratings, sections and elevations at critical points. Show coordination with lighting, ductwork, and diffusers, and indicate basic flow and hydraulic design information, including main location and date that the test was taken.

- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Provide the Owner with one copy of NFPA 25. Standard for the Inspection Testing and Maintenance of Water-based Fire Protection Systems.

1.4 EXTRA STOCK

- A. Provide metal storage cabinet, wrenches for each sprinkler type, and extra sprinklers per NFPA 13 and applicable building code.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store valves and sprinklers in shipping containers, with labels in place.
- B. Provide temporary protective coating on iron and steel valves.
- C. Maintain temporary end caps and closures in place until installation.

1.6 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves to General Contractor for placement in walls and floors. Sleeve location to be determined by the Fire Protection Contractor prior to construction. If additional sleeves are required, they shall be core drilled by the Fire Protection Contractor.

1.7 SYSTEM DESCRIPTION

- A. Contractor shall design and install the following water-based fire protection systems for the areas noted on the contract documents:
 - 1. Wet pipe sprinkler system(s)
- B. Sprinkler systems shall be designed and installed according to the following standard(s):
 - 1. NFPA 13 - Standard for the Installation of Sprinkler Systems
 - 2. FM Global Datasheet 2-0 - Installation Guideline for Automatic Sprinklers
 - 3. FM Global Datasheet 3-26 - Fire Protection Water Demand for Nonstorage Sprinklered Properties
- C. System design and installation shall include all requirements by the Authority Having Jurisdiction, local and state building codes, and Owner's insurance company in addition to the previously listed design standard(s). Those requirements shall take precedence over the contract documents in the case of discrepancies.
- D. Systems shall be hydraulically calculated in accordance with the applicable design standard(s). Contractor is responsible for final pipe sizing based on results from hydraulic calculations. Pipe sizing shown on drawings for service entrance and main risers is preliminary and for coordination purposes only.

- E. The water supply source for this project is the following:
 - 1. Public waterworks system with fire pump.
 - 2. Refer to Section 213000 for fire pump performance requirements.
 - 3. System design shall be based on a new hydrant flow test. Local fire authority or third-party consultant shall be contracted to determine the flow and pressure available at the service connection. The Fire Protection Contractor is responsible to verify this information and make all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 6 months
- F. Coordinate with Plumbing Contractor for installation of a floor drain or floor sink below the backflow preventer.

1.8 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 210500 for required fire protection systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

1.9 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturers' operation and maintenance data. Include written maintenance data on components of system, servicing requirements, and record drawings.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS - WET PIPE SPRINKLER SYSTEMS

- A. Piping - 2" and Under (Steel Pipe):
 - 1. Design Pressure: 175 psig
 - 2. Pipe: Schedule 40, black steel, ASTM A53, ASTM A795, UL/FM. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
 - 3. Schedule 40 Joints: Threaded or roll grooved (2" and 1.5" only) or flanged.
 - 4. Fittings:
 - a. Threaded:
 - 1) Cast iron, Class 125, black, UL/FM, ANSI/ASME B16.4.
 - 2) Malleable iron, Class 150, black, UL/FM, ANSI/ASME B16.3.
 - 3) Ductile iron, Class 150, black, UL/FM, ANSI/ASME B16.3.
 - b. Grooved:
 - 1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL/FM, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40F to 150F. Carbon steel bolts and nuts.

c. Flanged:

- 1) Cast iron, Class 125, black, UL/FM, ANSI/ASME B16.1.

5. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.

B. Piping - 2-1/2" and Above (Steel Pipe):

1. Design Pressure: 175 psig
2. Pipe: Schedule 40, black steel ASTM A53, ASTM A795, UL/FM. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
3. Joints: Roll Grooved or flanged.
4. Fittings:

a. Grooved:

- 1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL/FM, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40F to 150F. Carbon steel bolts and nuts.

b. Flanged:

- 1) Cast iron, Class 125, black, UL/FM, ANSI/ASME B16.1.

c. Saddle Branch Fittings:

- 1) In lieu of a TEE fitting for systems using steel piping where connecting a branch line to a main, saddle branch connections utilizing a bolted clamp or a U-bolt support around the main pipe with a ductile iron sealing surface and gasket are permitted based on these size limitations:
 - a) Up to 6" Mains: Branch pipe maximum size is nominally one pipe size smaller than main.
 - b) 8" and Larger Mains: Branch pipe maximum size is nominally two pipe sizes smaller than main.

C. Piping - 3" and Under (CVPC):

1. Design Pressure: 175 psig
2. Tubing: Chlorinated polyvinyl chloride (CPVC), standard dimensional ratio (SDR) of 13.5, NSF certified for use with potable water, UL/FM.
 - a. Joints: Solvent Cement, ASTM 493, ASTM F402, NSF certified for use with potable water.
 - b. Fittings: Same as tubing. Fittings and tubing shall be a system provided by the same manufacturer. ASTM F437, ASTM F438, ASTM F439. Threaded adapters for threaded valves shall be metal threaded adapter with solvent socket, UL/FM.

3. CPVC shall be listed for use in the following situations:
 - a. Light Hazard Occupancies, as defined in NFPA 13.
 - b. Residential Occupancies, as defined in NFPA 13R.
 - c. Air plenums per the requirements of UL 1887, as defined by NFPA 90A and the International Mechanical Code (IMC).
 4. CPVC Compatibility:
 - a. CPVC pipe and fittings shall be evaluated for chemical compatibility with internally coated anti-MIC coatings provided in steel piping. All CPVC piping must be compatible with steel pipe containing corrosion inhibitors.
 - b. Ancillary products, such as firestopping, thread sealants, cutting oils, etc., coming into contact with both pipe and fittings shall be chemically compatible.
 - c. When CPVC is used in combination (e.g., steel and CPVC) systems, the Contractor shall provide a letter stating that all products used in conjunction with the system have been investigated and found to be compatible with CPVC.
- D. Piping - 3" and Under (Seamless Copper Tube):
1. Design Pressure: 125 psig.
 2. Piping - 3" and Under:
 - a. Tubing: Type L drawn temper seamless copper tube, ASTM B88.
 - b. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.
 - c. Fittings: Wrought copper solder joint, ASME B16.22.
 3. Usage: Inside MRI spaces.

2.2 FLEXIBLE FIRE SPRINKLER CONNECTIONS

- A. Flexible Connection: Stainless steel hose, 175 psig max working pressure, fully welded non-mechanical fittings, stainless steel braid, maximum of 6' hose length, leak-tested with a minimum 7/8" internal corrugated hose diameter made of 304 stainless steel, end fittings made of carbon or stainless steel. Outlet of end fittings shall be 1/2" or 3/4" to match sprinkler connection. UL/FM.
- B. Ceiling Bracket: G90 galvanized steel, direct attachment type, integrated snap-on clip ends, tamper resistance screws, removable attachment hub with set screw for attachment and adjustment of stainless steel hose.
 1. Manufacturers:
 - a. Flexhead Industries
 - b. Victaulic VicFlex,
 - c. Sprinkflex
 - d. or approved equal.

2.3 VALVES

- A. Provide handwheels for gate valves. Provide gear operators for butterfly valves.
- B. Provide all connections to match pipe joints. Valves shall be same size as pipe.

2.4 EQUIPMENT

- A. Equipment shall be as scheduled on the drawings.

2.5 RISER LABELING AND IDENTIFICATION

- A. Hydraulic nameplates shall be affixed to each riser and shall include the following minimum information:
 - 1. Installation contractor
 - 2. Date installed
 - 3. Riser location
 - 4. Number of sprinklers
 - 5. Basis of design (density GPM/ft² and area of coverage ft²)
 - 6. Water flow rate (GPM) and residual pressure (psi) at the base of riser
 - 7. Hose stream allowance (GPM).
 - 8. Occupancy classification
 - 9. Commodity classification (If applicable)
 - 10. Maximum storage height (if applicable)
- B. A dedicated antifreeze placard is required where a remote antifreeze system is provided. The placard is to be placed on the main valve serving the antifreeze system to document the manufacturer type and brand of the solution and the system volume.

2.6 PIPE LABELING AND IDENTIFICATION

- A. All pipe shall be marked along its length by the manufacturer in such a way as to properly identify the type of pipe. The manufacturer pipe marking shall be visible on every piece of pipe over 2 ft (600 mm) long. Manufacturer pipe identification shall include the manufacturer's name, model designation, and/or schedule. Provide additional identification as described in Section 210553.

PART 3 - EXECUTION

3.1 INSTALLATION - PIPING

- A. General Installation Requirements:
 - 1. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over sprinkler piping and sprinklers.
 - 2. Ream pipe and tube ends to full inside diameter. Remove burrs. Remove scale and foreign material, inside and outside, before assembly.
 - 3. Die cut screw joints with full cut standard taper pipe threads.

4. Coat threads with pipe joint compound or wrap with Teflon tape.
5. Locate piping to minimize obstruction of other work.
6. Route piping in concealed spaces above finished ceiling.
7. Use full and double lengths of pipe wherever possible.
8. Slope all piping for complete drainage. Install auxiliary drains for all trapped piping per NFPA 13.
9. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
10. Comply with manufacturer's installation instructions.

B. Wall/Floor Penetration:

1. Provide sleeves when penetrating floors and walls.
2. Seal pipes passing through exterior walls with a wall seal per Section 210529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe. Sleeves through floors shall extend minimum 1.5" above finished floor.
3. Fire seal all pipe and sleeve penetrations (both wall and floor) to maintain fire separation required without restraining pipe.

C. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment. Fire protection equipment dedicated to the electrical equipment room or space may be installed above equipment if other alternatives are not available.

D. Installation Requirements in MRI (Magnetic Resonance Imaging - Healthcare):

1. Provide non-ferrous semi-recessed chrome plated head and escutcheon.
2. All piping in MRI rooms shall be non-ferrous regardless of materials described in Part 2.

E. Hangers and Supports:

1. Provide hangers and supports as required by NFPA 13 and UL/FM, with the following exceptions:
 - a. Do not use powder driven devices, explosive devices, wooden plugs, or plastic inserts.
 - b. Do not install fasteners to carry the load in tension, unless absolutely necessary.

F. Exposed Piping:

1. Install chrome plated steel escutcheons where exposed pipes penetrate walls or floors.
2. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.

3.2 INSTALLATION - VALVES

- A. Install gate valves with stems upright or horizontal, not inverted.
- B. Shutoff Valve:
 - 1. Install buried shutoff valves in valve boxes. Provide post indicators.
 - 2. Provide drain valves at main shutoff valves, low points of piping and apparatus.
 - 3. Provide monitor switches on all shutoff valves.

3.3 INSTALLATION - EQUIPMENT

- A. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over system equipment and sprinklers.
- B. Fire Department Connection:
 - 1. Locate fire department connection in an accessible location as approved by the local fire department with sufficient clearance from walls, obstructions, and adjacent Siamese connectors to allow full swing of fire department wrench handle.
- C. Test Valves:
 - 1. Install test valves where required. Pipe to outdoors or drain. Test connection shall have flow equivalent to the smallest K-factor sprinkler.
- D. Sprinklers:
 - 1. Locate sprinklers to clear lights, ducts and diffusers. Do not run sprinkler pipes through ducts. Ductwork has priority over sprinkler pipes. Offset pipes as needed.
 - 2. Center sprinklers in two directions in ceiling tiles and provide offsets as required.
 - 3. Do not allow concealed sprinkler cover plates to be painted. Sprinkler cover plates are to be factory painted only. Do not field paint.
 - 4. Apply strippable or paper covers so concealed sprinkler cover plates do not receive field paint finish.

3.4 SYSTEMS CLEANING AND TESTING

- A. General Requirement:
 - 1. All water used for testing and remaining in the piping system shall be obtained from a potable water source.
- B. Interior Piping:
 - 1. Verify adequate water flow at the inspector's test connection.
 - 2. Flush all interior piping to remove scale and other foreign material before placing system into service.

3. Hydrostatically test the entire interior piping system at a minimum of 200 psig or 50 psig more than the normal system working pressure for systems subjected to pressures more than 150 psig. Maintain test pressure for 2 hours without loss of pressure. Test shall be performed with dry pipe valves in open position to prevent valve damage.

C. Fire Alarm System:

1. Test the alarm system by operating the inspector's test connection or the alarm test valves. Verify that the building fire alarm system activates.
2. Adjust all monitor switches for proper operation.

3.5 INSTALLATION - CORROSION PRODUCTS/NITROGEN GENERATOR EQUIPMENT

A. General Installation Requirements:

1. Comply with manufacturer's installation instructions.

B. System Start-up and Commissioning Protocol:

1. Confirm the operation of system air compressor and connect air compressor and nitrogen generator to the dry pipe system.
2. Determine the operating pressure range for the dry/preaction system and set the system air maintenance device for each zone to the correct setting.
3. Confirm the air maintenance device is taken out of the fast fill (by-pass) setting when the system is placed in service.
4. Confirm the water discharge from the air compressor drain and the Nitrogen Generator drain are piped to a floor drain or building exterior per local requirements.
5. Confirm that back pressure regulator of each dry pipe valve is set to close above the low air pressure alarm of the dry pipe system. The isolation ball valve of each device shall be closed during hydrostatic and/or air pressure testing of the dry pipe system and then placed in the open position for the commissioning and operation of the system.
6. Coordinate with Nitrogen System manufacturer to establish and record the final pressure range settings of the nitrogen generator system to coordinate with the dry pipe system operational pressure ranges.

END OF SECTION

SECTION 220500 - BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
 - a. Plumbing Contractor.
 - b. Heating Contractor.
 - c. Air Conditioning and Ventilating Contractor.
 - d. Temperature Control Contractor.
 - e. Fire Protection Contractor.
 - f. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
 - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.

6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
 - a. Light fixtures.
 - b. Gravity flow piping, including steam and condensate.
 - c. Electrical busduct.
 - d. Sheet metal.
 - e. Electrical cable trays, including access space.
 - f. Sprinkler piping and other piping.
 - g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
 - a. Boiler Feed Pumps.
 - b. Burners.
 - c. Chillers.
 - d. Computer Room Air Conditioning Units.
 - e. Condensate Return Stations.
 - f. Condensing Units.
 - g. Makeup Air Units.
 - h. Electric Humidifiers.
 - i. Gas Trains.
 - j. Package Air Handling Units.
 - k. Packaged Rooftop Units.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
 - a. Wiring of all devices needed to make the Temperature Control System functional.
 - b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
 - c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.

5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.3 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
 - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect/Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Architect/Engineer and Owner's Representative. The Architect/Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.

2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The Architect/Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect/Engineer.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the Architect/Engineer at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect/Engineer and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.4 QUALITY ASSURANCE

- A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Rogers, AR Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all published standards of Mercy Health.
3. Conform to all State Codes.
4. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.
5. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
6. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
7. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
8. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
9. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.

2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriters' Laboratories, Inc. and approved by FM Global.

E. Examination of Drawings:

1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 - a. Any item listed as furnished shall also be installed, unless otherwise noted.
 - b. Any item listed as installed shall also be furnished, unless otherwise noted.

F. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.

2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.5 WEB-BASED PROJECT SOFTWARE

- A. The General Contractor shall provide a web-based project software site for the purpose of hosting and managing project communication and documentation until completion of the warranty phase.
- B. The web-based project software shall include, at a minimum, the following features: construction schedule, submittals, RFIs, ASIs, construction change directives, change orders, drawing management, specification management, payment applications, contract modifications, meeting minutes, construction progress photos.
- C. Provide web-based project software user licenses for use by the Architect/Engineer. Access will be provided from the start of the project through the completion of the warranty phase.
- D. At project completion, provide digital archive of entire project in format that is readable by common desktop software applications in format acceptable to Architect/Engineer. Provide data in locked format to prevent further changes.

1.6 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals List:

Referenced Specification	Submittal Item
Section 22 05 00	Owner Training Agenda

Referenced Specification Section	Submittal Item
22 05 50	Seismic Restraint Systems
22 05 53	Plumbing Identification
22 09 00	Instrumentation
22 10 00	Plumbing Piping Systems and Valves
22 10 30	Plumbing Specialties
22 30 00	Plumbing Equipment
22 40 00	Plumbing Fixtures

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
 - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 22 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 22 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.7 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
 - 1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
 - 2. Submit in Excel format.
 - 3. Support values given with substantiating data.
- C. Preparation:
 - 1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
 - 2. Break down all costs into:
 - a. Material: Delivered cost of product with taxes paid.
 - b. Labor: Labor cost, excluding overhead and profit.
 - 3. Itemize the cost for each of the following:
 - a. Overhead and profit.
 - b. Bonds.
 - c. Insurance.
 - d. General Requirements: Itemize all requirements.
 - 4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
 - a. Excavation and backfill for underground piping systems inside the building.
 - b. Underground piping systems inside the building (sanitary, storm, etc.) listed separately. Break down the material and labor for each piping system based on geography (building, floor, wing and/or phase).
 - c. Each aboveground piping system (sanitary, storm, domestic water, etc.). Break down the material and labor for each piping system based on geography (building, floor, wing and/or phase).
 - d. Pipe insulation with separate material and labor line items for each piping system listed above.
 - e. Each piece of equipment requiring shop drawings (e.g., backflow preventer, water heater, water softener, etc.) using the project nomenclature (BFP-1, WH-1, WS-1, etc.).
 - f. Each plumbing fixture (e.g., WC, lavatory, sink, etc.). Multiple units of the same type can be listed together, provided quantities are also listed so unit costs can be determined.
 - g. Site utilities (5' beyond building)
 - h. Seismic design
 - i. Water balancing
 - j. Commissioning

- k. Record drawings
- l. Punchlist and closeout

D. Update Schedule of Values when:

- 1. Indicated by Architect/Engineer.
- 2. Change of subcontractor or supplier occurs.
- 3. Change of product or equipment occurs.

1.8 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.9 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
 - 1. Fire Seal Systems
 - 2. Seismic Restraints and Equipment Bracing
 - 3. Vibration Isolation
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Protect equipment, components, and openings with airtight covers and exercise care at every stage of storage, handling, and installation of equipment to prevent airborne dust and dirt from entering or fouling equipment to include, but not limited to:

1. Motor windings and ventilation openings.
 2. Bearings.
 3. Equipment Pipe and Accessories connection openings. (e.g. boiler connections, coil connections, etc.)
 4. Starter and control cabinets.
 5. Heat transfer coils.
 6. Pump Seals.
 7. Combustion burner and blower equipment (e.g. combustion air intake, combustion vent/flue, etc.)
- C. Equipment and components that are visibly damaged or have been subject to environmental conditions prior to building turnover to Owner that could shorten the life of the component (for example, water damage, humidity, dust and debris, excessive hot or cold storage location, etc.) shall be repaired or replaced with new equipment or components without additional cost to the building owner.
- D. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- E. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- F. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.
- 1.11 NETWORK / INTERNET CONNECTED EQUIPMENT
- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.
- 1.12 WARRANTY
- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.13 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.14 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the first manufacturer is the basis for job design and establishes the quality.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractor's part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

1.15 PROJECT COMMISSIONING

- A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 22 08 00 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:
 - 1. Placing fill over underground and underslab utilities.
 - 2. Covering exterior walls, interior partitions and chases.
 - 3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
 - 1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
 - a. Pipe insulation is installed and fully sealed.
 - b. Pipe wall penetrations are sealed.
 - c. Pipe identification and valve tags are installed.
 - 2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
 - 3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
 - 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
 - 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
 - 3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
 - 4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, this Contractor must submit the following:
 - 1. Operation and maintenance manuals with copies of approved shop drawings.
 - 2. Record documents including marked-up or reproducible drawings and specifications.
 - 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
 - 4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
 - 5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.4 OPERATION AND MAINTENANCE MANUALS

- A. General:
 - 1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
 - 2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div22.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div22.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.

11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.
16. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
 1. Explanation of all system flow diagrams.
 2. Maintenance of equipment.
 3. Start-up procedures for all major equipment.
 4. Explanation of seasonal system changes.
 5. Explanation of Owner's Responsibilities to operate, maintain, and flush domestic water system (i.e., ASHRAE Standard 188).
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
 1. Water Softener, Filtration and/or Purification System - 2 hours
- G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of four weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
- H. Operating Instructions:
 1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
 2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.6 SYSTEM STARTING AND ADJUSTING

- A. The plumbing systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.7 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of plumbing drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations devices, requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.
- D. Before completion of the project, a set of reproducible plumbing drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.

- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.8 PAINTING

- A. This Contractor shall paint the following items:
 - 1. All piping in mechanical room
 - 2. Piping exposed in kitchen
- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.
- D. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.
- F. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- G. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.
- H. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
 - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
 - 2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.
 - 3. Color of paint shall be as follows:

a. All piping in mechanical room:

- 1) Domestic Cold Water: Blue pipe/white letters
- 2) Domestic Hot Water: Red pipe/white letters
- 3) Sanitary Waste: Green pipe/black letters
- 4) Natural Gas: Yellow pipe/black letters

3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.11 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
 1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
 - a. Minimizing the amount of dust generated.
 - b. Reducing solvent fumes and VOC emissions.
 - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
 - d. Protect stored on-site and installed absorptive materials from moisture damage.
 2. Request that the Owner designate an IAQ representative.

3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
6. Request copies of and follow all of the Owner's IAQ and infection control policies.
7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All pumps operating and balanced.
3. All plumbing fixtures installed and caulked.
4. Pipe insulation complete, pipes labeled and valves tagged.
5. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 220505 - PLUMBING DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Mechanical Demolition.
- B. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.
- B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.
- C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.
- D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.
- E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.
- F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.
- G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.2 PREPARATION

- A. Disconnect plumbing systems in walls, floors, and ceilings scheduled for removal.

- B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.
- C. Existing Plumbing System: Maintain service to all plumbing fixtures until new piping is installed. Obtain permission from Owner at least 48 hours before shutting down system for any reason. Make changeover to new piping with minimum outage. Do not disconnect any roof drainage piping until new piping is in place and operational. Existing Medical Gas System: Maintain existing system in service until new system is complete and ready for service. Modify existing system only to make switchovers and connections. Obtain permission from the Owner at least 48 hours before system modification. Minimize outage duration. Certify system same day as new connections are made.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

- A. Demolish and extend existing plumbing work under provisions of Division 2 and this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned piping to source of supply and/or main lines.
- D. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.
- E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Extend existing installations using materials and methods compatible with existing installations, or as specified.
- H. Remove unused sections of domestic water piping back to active mains and cap. Capped pipe length shall be less than 1.5 times the capped pipe diameter to prevent "dead legs".
- I. Temporarily cap all openings to the sanitary and vent system to prevent odor from entering the work area and building.

3.4 CUTTING AND PATCHING

- A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 220529 for additional requirements.
- B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

- C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.
- D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.
- E. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to discipline plans for additional information.
- F. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes X-ray or similar non-destructive means.
- G. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.5 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.
- C. PLUMBING ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.6 SPECIAL REQUIREMENTS

- A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.
- B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.
- C. All medical gas piping scheduled for removal, relocation, extension, and/or revision will require re-certification by an independent agency acceptable to the Owner and NFPA-99 requirements. All testing shall conform to NFPA-99.

END OF SECTION

SECTION 220529 - PLUMBING SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Flashing and Sealing of Equipment and Pipe Stacks.
- D. Cutting of Openings.
- E. Escutcheon Plates and Trim.

1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:
 - 1. Steel, Cast Iron, and Glass Pipe:

- a. Hanger Rod Diameter:

- 1) 2" and smaller: 3/8"
 - 2) 2-1/2" through 3-5/8": 1/2"
 - 3) 4" through 6": 1/2"
 - 4) 8": 5/8"
 - 5) 10": 3/4"
 - 6) 12": 7/8"
 - 7) 14" and 16": 1"
 - 8) 18" and 24": 1-1/4"

- 2. Copper and Plastic Pipe:

- a. Hanger Rod Diameter:

- 1) 2" and smaller: 3/8"
 - 2) 2-1/2") through 3-5/8": 1/2"
 - 3) 4") through 6": 1/2"
 - 4) 8": 5/8"
 - 5) 10": 3/4"
 - 6) 12": 7/8"
 - 7) 14" and 16": 1"
 - 8) 18" and 24": 1-1/4"

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:

2.2 PIPE AND STRUCTURAL SUPPORTS

A. General:

- 1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
- 2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.
- 3. Copper piping located in an exposed area, including indirect waste piping in janitor's closets, shall use split ring standoff hangers for copper tubing. Support shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp. Use electro-galvanized or more corrosion resistant and threaded rod for floor applications. Use anchors applicable to the wall type with corrosion resistant threaded rod for wall applications.

a. Products:

- 1) nVent/M-Co Model #456
- 2) Eaton Fig. 3198HCT
- 3) Anvil Fig. CT138R

B. Hangers and Clamps:

- 1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
- 2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp within their temperature limits of -65F to +275F.
- 3. Vertical cold pipe drops and rough-ins to fixtures shall be supported by insulated pipe clamps to prevent thermal bridging and condensation.
- 4. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
- 5. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.

- a. Products:
 - 1) Anvil Fig. 160, 161, 162, 163, 164, 165
 - 2) Eaton Fig. 3160, 3161, 3162, 3163, 3164, 3165
 - 3) nVent Model 630, 631, 632, 633, 634, 635
- 6. Unless otherwise indicated, hangers shall be as follows:
 - a. Clevis Type: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches & Smaller
 - 1) Products: Bare Steel Plastic or Insulated Pipe:
 - a) Anvil Fig. 260
 - b) Eaton Fig. 3100
 - c) nVent Model 400
 - 2) Products: Bare Copper Pipe Felt or PVC Coated:
 - a) Eaton Fig. B3104F or B3100CTC
 - b) Anvil Fig. CT65
 - c) nVent Fig. 402
 - b. Continuous Channel with Clevis Type: Service: Plastic Tubing, Flexible Hose, Soft Copper Tubing:
 - 1) Products:
 - a) Eaton Fig. B3106, with Fig. B3106V
 - b) nVent Model 104, with Model 104V
 - c) Anvil Fig. 1V
 - c. Adjustable Swivel Ring Type: Bare Metal Pipe - 4 inches and Smaller
 - 1) Products: Bare Steel Pipe:
 - a) Anvil Fig. 69
 - b) Eaton Fig. B3170NF
 - c) nVent Model 115
 - 2) Products: Bare Copper Pipe:
 - a) Eaton Fig. B3170CTC
 - b) nVent 102A0 Series
 - c) Anvil Fig. CT-69
- 7. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.

- a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
 - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
8. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
- a. Clamp Type: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller
 - 1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp.
 - 2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
 - 3) Products: Bare Steel, Plastic or Insulated Pipe:
 - a) Unistrut Fig. P1100 or P2500
 - b) Eaton Fig. B2000 or B2400
 - c) Anvil Fig. AS1200
 - d) nVent USC
 - 4) Products: Bare Copper Pipe:
 - a) Eaton Fig. BVT
 - b) nVent CADDY Cushion Clamp
- C. Upper (Structural) Attachments:
1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
- a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists):
 - 1) Products:
 - a) Anvil Fig. 86
 - b) Eaton Fig. B3033/B3034
 - c) nVent Model 300 & 310
 - b. Steel Structure Clamps: Scissor Type Beam Clamps (for use with bar-joists and wide flange):
 - 1) Products:
 - a) Anvil Fig. 228, 292
 - b) Eaton Fig. B3054
 - c) nVent Model 360

- c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):
 - 1) Products:
 - a) MCL. M1, M2 or M3
- d. Steel Structure Welding:
 - 1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

2.3 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

- 1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
- 2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

- 1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 6 inches on all sides of the equipment (6 inches larger than factory base), except where pad extension would interfere with working space at equipment control panels and electrical panels.
- 2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
- 3. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.
- 4. Equipment requiring bases is as follows:
 - a. Water Softener

C. Supports:

- 1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
- 2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.
- F. Exposed Housing Penetrations: Seal pipes with surface temperature below 150F, penetrating housings with conical stepped, white silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite.

2.5 ROOF PENETRATIONS

- A. Roof Curb Enclosure: Provide weatherproof roof curb and enclosure for pipe penetrations. Refer to drawings for details.
- B. Conical Pipe Boot: Seal pipes with surface temperature below 150F, penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: shall match roofing membrane.
- C. Break insulation only at the clamp for pipes between 60F and 150F. Seal outdoor insulation edges watertight.

		Element	
Mode	Service	Material	Temperature Range
I			

S	Standard (Stainless)	EPDM	-40F to 250F
T	High/Low Temperature (Steam)	Silicone	-67F to 400F
T	Fire Seals (1 hour)	Silicone	-67F to 400F
FS	Fire Seals (3 hours)	Silicone	-67F to 400F
OS	Oil Resistant/Stainless	Nitrile	-40F to 210F

2.6 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.7 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.8 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.9 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 PLUMBING SUPPORTS AND ANCHORS

- A. General Installation Requirements:
 - 1. Install all items per manufacturer's instructions.
 - 2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.

3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with Sheet Metal Contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. For attachments to joists that are concentrically loaded on the joist, a max of 100 lbs may be attached to the joist within a chord panel.
2. For attachments to joists that are eccentrically loaded, a max of 25 lbs may be attached to the joist within a chord panel without an additional angle.
3. Multiple attachments are allowed in each chord panel as long as the sum of the loads do not exceed the max load indicated.
4. For loads between 100 lbs - 200 lbs, additional L2x2x3/16" (L51xL51x4.8) ASTM A36 structural steel angles are required and joist must be concentrically loaded.

5. For loading conditions noted above, total sum of loads shall not exceed 200 lbs for an 8 ft segment of joist. For loads greater than 200 lbs and not noted on the drawings, contact engineer prior to installation.
 6. No loads shall be supported from joist bridging.
 7. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
 8. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):
 - a. Maximum Spacing:
 - 1) 1-1/4" & under: 7'-0"
 - 2) 1-1/2": 9'-0"
 - 3) 2": 10'-0"
 - 4) 2-1/2": 11'-0"
 - 5) 3": 12'-0"
 - 6) 4" & larger: 12'-0"
- I. Installation of hangers shall conform to MSS SP-58, 69, 89 and the applicable Plumbing Code.

END OF SECTION

SECTION 220553 - PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Identification of products installed under Division 22.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. 3M
2. Bunting
3. Calpico
4. Craftmark
5. Emedco
6. Kolbi Industries
7. Seton
8. W.H. Brady
9. Marking Services

2.2 MATERIALS

- A. All pipe markers shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

Plastic tags may be used for outside diameters under 3/4"

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

- F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.
- H. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.
- I. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape 6" wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item.
- J. Tracer Wire:
 - 1. Single copper conductors shall be solid or stranded annealed or hard uncoated copper per UL83 and ASTM requirements. Tracer tape or copper-coated steel wire is not acceptable.
 - 2. Conductor shall be insulated with HMWPE as specified and applied in a concentric manner. The minimum at any point shall not be less than 90% of the specified average thickness in compliance with UL 83.
 - 3. Tracer wire shall be continuously spark tested at 7500 Volts DC. Other electrical and mechanical tests shall be in accordance with UL 1581.
- K. Ceiling Markers:
 - 1. Label Style:
 - a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves. An arrow can be used to point to the tile needing removal.
 - b. The label tape shall be approximately 1/2" wide with all capitalized letters approximately 3/16" tall.
 - c. Ceiling grid labels shall be made with a label maker with durable adhesive labels having a clear background and black letters.
 - d. Equipment labels shall be as designated on the drawings (e.g., WHA, TP, etc.).
 - e. Valve labels shall be designated by the size, service, and the valve tag number (e.g., 1-1/4" CW #123, 2" HWS #234, etc.). A single longer label can be used to identify multiple valves using spaces between the descriptors if the valves are located close together and have the same service (e.g., CW, HW, and HWC lines serving the same restroom, etc.).
 - 2. "Dot" Style:
 - a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves.

- b. The marker shall be a self-adhesive color dot approximately 1/2" in diameter.
- c. The equipment and accessories to be marked and dot color shall be coordinated with the Architect/Engineer and Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
 - 1. All valves (except shutoff valves at equipment) shall have numbered tags.
 - 2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
 - 3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
 - 4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
 - 5. Attach to handwheel or around valve stem.
 - 6. Number all tags and show the service of the pipe.
 - 7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
- D. Pipe Markers:
 - 1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
 - 2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
 - 3. Stencil Painted Pipe Markers:
 - a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
 - b. Apply primer on non-insulated pipes before painting.
 - c. Use background and letter colors as scheduled later in this section.
 - 4. Apply markers and arrows in the following locations where clearly visible:
 - a. At each valve.
 - b. On both sides of walls that pipes penetrate.
 - c. At least every 20 feet along all pipes.
 - d. On each riser and each leg of each "T" joint.
 - e. At least once in every room and each story traversed.

5. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Provide engraved plastic tags at all hydronic or steam system makeup water meters.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

F. Tracer Wire:

1. Tracer wire shall be installed on top of all non-metallic buried utilities.
2. Tracer wire shall be taped directly to plastic water or drain pipe.
3. Tracer wire shall not be fastened directly or indirectly to gas piping.
4. Tracer wire when attached shall be secured to the pipe a minimum of every 10 feet and at all changes of direction.
5. Tape shall be Polyken "930-35", Protecto-Wrap "310", or approved equal.
6. Tracer wire shall be continuous between boxes and shall be tested for continuity.
7. Splices in tracer wire shall be made with a water proof splice kit to prevent corrosion. Wire nuts shall not be used.
8. The tracer wire shall daylight to grade through a 2" PVC conduit, at the point of the utility entrance to building. PVC conduit shall be capped and labeled as future contact point to locate the utility.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. CONDENSATE DRAIN: White lettering; green background
2. DOMESTIC COLD WATER: White lettering; green background
3. DOMESTIC HOT WATER - 115F: White lettering; green background
4. DOMESTIC HOT WATER - 140F: White lettering; green background
5. DOMESTIC HOT WATER CIRCULATING - 115F: White lettering; green background
6. DOMESTIC HOT WATER CIRCULATING - 140F: White lettering; green background
7. SANITARY SEWER: Black lettering; yellow background
8. VENT: Black lettering; yellow background
9. STORM SEWER (PRIMARY AND SECONDARY): White lettering; green background
10. MEDICAL VACUUM - 15-30 IN. HG: Black lettering; white background
11. WASTE ANESTHETIC GAS DISPOSAL - 15-30 IN. HG: White lettering; violet background

12. MEDICAL VACUUM and WASTE ANESTHETIC GAS DISPOSAL - 15-30 IN. HG
Dual labeled: VAC Black lettering; white background, WAGD White lettering;
violet background
 13. CARBON DIOXIDE - 50-55 PSI: White lettering; gray background
 14. INSTRUMENT AIR - 160-185 PSI: White lettering; red background
 15. MEDICAL AIR - 50-55 PSI: Black lettering; yellow background
 16. NITROGEN - 160-185 PSI: White lettering; black background
 17. NITROUS OXIDE - 50-55 PSI: White lettering; blue background
 18. OXYGEN - 50-55 PSI: White lettering; green background
 19. All Underground Pipes: Varies
 20. Tracer Wire - Natural Gas Pipe Lines: Black lettering; yellow background
 21. Tracer Wire - All other buried types: White lettering; green background
- B. Non-Potable Piping: All piping conveying non-potable water shall be permanently identified by continuously painted or continuous adhesive backed marker along entire length of pipe and branches so the piping is readily distinguishable from piping carrying potable water. Pipe markers shall be located as described above.
1. NON-POTABLE WATER: White lettering; purple background
 2. DEIONIZED WATER: White lettering; purple background
- C. Medical gas pipe markers shall include the system operating pressure shown above.
- D. Medical gas pipe markers shall meet the pipe labeling requirements of NFPA-99.
- E. Ceiling Markers:
1. CLEAN OUT Condensate, Sanitary, Storm, Etc.
 2. WATER HAMMER ARRESTOR
 3. CONTROL VALVE
 4. TRAP PRIMER
 5. HWC BALANCING/CONTROL VALVE

END OF SECTION

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping Insulation.
- B. Insulation Jackets.

1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with five years minimum experience.
- B. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
- B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534 Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75F, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.

2.2 VAPOR BARRIER JACKETS

- A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.
- B. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

2.3 JACKET COVERINGS

- A. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40F to 150F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

3.2 INSTALLATION

- A. General Installation Requirements:
 - 1. Install materials per manufacturer's instructions, building codes and industry standards.
 - 2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
- B. Insulated Piping Operating Below 60F:
 - 1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
 - 2. On piping operating below 60F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
 - 3. All balance valves with fluid operating below 60F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.
- C. Insulated Piping Operating Between 60F and 140F:
 - 1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Insulated Piping Operating Above 140F:

1. Insulate fittings, valves, flanges, and strainers.
2. All balance valves with fluid operating above 140F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.

E. Exposed Piping:

1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.
3. On exposed piping serving kitchen equipment or plumbing fixtures, the piping shall be insulated unless local code allows it to be uninsulated. In no instance should the uninsulated portion of the piping be more than 4ft in developed length.

3.3 SUPPORT PROTECTION

A. Insulation with pipe size greater than 1-1/2" (38mm) shall be protected from sagging and crushing by one of the following means.

1. High Compressive Strength Insert: On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:
 - a. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180-degree cylindrical segment the same length as metal shields. Inserts shall be:
 - b. Provide metal shields between hangers or supports and the pipe insulation/insert. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.
 - 1) Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5" to 6"	18" long x 16 gauge
8" to 14"	24" long x 14 gauge
16" to 24"	24" long x 12 gauge
 - c. Where rolled steel plate is noted above, provide minimum 1/4" (6mm) rolled galvanized steel plates in addition to the shield as reinforcement on large pipes as noted above to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength.
2. Premanufactured Insulation Insert/Shield: As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.

- a. Products:
 - 1) Buckaroo CoolDry
 - 2) Cooper/B-Line Fig. B3380 through B3384
 - 3) Pipe Shields A1000, A2000
 - 3. Premanufactured Insulation Couplings:
 - a. Molded thermoplastic slip coupling, -65F to 275F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
 - b. PET thermoplastic foam load bearing core with elastomeric foam ends and lap-seal jacket.
 - c. Horizontal Strut Mounted Insulated Pipe Manufacturers:
 - 1) Klo-Shure or equal
 - 2) Armafix Ecolight
 - d. Vertical:
 - 1) Manufacturers: Klo-Shure Titan or equal
 - 4. Premanufactured shield/saddle for use with Elastomeric Foam (Type B): Molded thermoplastic rigid pipe saddle sized for insulation outside diameter. Length as required by manufacturer.
- B. Rectangular blocks, plugs, or wood material are not acceptable.
 - C. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.
 - D. Neatly finish insulation at supports, protrusions, and interruptions.
- 3.4 INSULATION
- A. Type A Insulation:
 - 1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
 - 2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
 - 3. Apply insulation with laps on top of pipe.

4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60F, seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer's instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Exterior installations shall contain factory applied polymeric, moisture, and UV resistant covering with ends sealed with adhesive and similar cover; or Contractor shall paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
 - a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
 - a. Install preformed sections of same material as straight segments of pipe insulation when available.
 - b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3.5 JACKET COVER INSTALLATION

A. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. Use plastic insulation covering on all exposed pipes including, but not limited to:
 - a. All exposed piping in finished spaces unless noted otherwise on the drawings.

- b. All exposed piping in locker rooms.
 - c. All exposed piping adjacent to cloud ceilings.
 - d. All exposed piping in unfinished areas as noted on drawings (e.g., storage rooms, janitor's closets, utility rooms, etc.).
 - e. All exposed piping in mechanical or equipment rooms below 8'-0" above floor.
 - f. All exposed piping in mechanical rooms that is subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)
 - g. All exposed piping in tunnels designated as passageways, equipment access, or egress.
5. Elastomeric piping insulation may have two coats of latex paint instead of plastic jacket.

3.6 SCHEDULE

- A. Refer to drawings for insulation schedule.

END OF SECTION

SECTION 220800 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Description
- B. Responsibilities
- C. Related Work
- D. Test Equipment

1.2 DESCRIPTION

- A. The purpose of this section is to specify Division 22 responsibilities in the commissioning process.
- B. The systems to be commissioned are listed in Section 019100.
- C. Commissioning requires the participation of the Division 22 Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 019100. Division 22 Contractor shall be familiar with all parts of Section 019100 and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.3 RESPONSIBILITIES

- A. Refer to Section 019100.

1.4 RELATED WORK

- A. Specific commissioning requirements are given in the following sections of these specifications. All the following sections apply to the Work of this section.
 - 1. Section 017823 - Operations and Maintenance
 - 2. Section 017900 - Demonstration and Training
 - 3. Section 019100 - Commissioning
 - 4. Section 210800 - Commissioning of Fire Suppression
 - 5. Section 230800 - Commissioning of HVAC
 - 6. Section 260800 - Commissioning of Electrical
 - 7. Section 270800 - Commissioning of Communications

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall provide all test equipment necessary to fulfill the testing requirements of this Division. This equipment includes, but is not limited to, the following:
 - 1. Handheld temperature and relative humidity meter.
 - 2. Infrared thermometer gun.
 - 3. Analog differential pressure gauge and associated tubing.
 - 4. Portable computer with access to the building automation system.
- B. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the related specifications. If not otherwise noted, the following minimum requirements apply:
 - 1. Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5F and a resolution of +/- 0.1F.
 - 2. Pressure sensors shall have an accuracy of +/- 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
 - 3. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.
- C. Refer to Section 019100 for additional Division 22 requirements.

PART 3 - EXECUTION

- A. Refer to Section 019100.

END OF SECTION

SECTION 221000 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Check Valves.

1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.
- D. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.3 DELIVERY, STORAGE, AND HANDLING

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

1.4 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 220500 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 CAST IRON PIPE

- A. Cast Iron; Standard Weight; Hub and Spigot Joints:
 - 1. Pipe: Standard weight hub and spigot cast iron soil pipe, bituminous corrosion protective coating inside and outside, CISPI 301 and CISPI Trademark.
 - 2. Design Pressure: Gravity Maximum Design Temperature: 180F.
 - 3. Joints: Compression gasket, ASTM C564.
 - 4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 301. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.

5. Adapters: Heavy duty no-hub transition for joining cast iron and PVC pipe. Adapters shall be tested and certified to ASTM C 1460 and be constructed with Type 304 stainless steel shield, thickness 0.015" shield, gasket material to meet ASTM C564, 1-1/2" to 4" will be 3" wide with four 304 stainless steel bands, and 6" to 10" will be 4" wide with six 304 stainless steel bands and 3/8" 305 stainless steel hex head screws torqued to 80 inch pounds.

B. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets:

1. Pipe: Standard weight no-hub cast iron soil pipe, bituminous corrosion protective coating inside and outside, CISPI 301 and CISPI Trademark.
2. Design Pressure: Gravity Maximum Design Temperature: 180F.
3. Joints: ASTM C1540, FM 1680, and ASTM C-564.
 - a. Super Duty, Shielded Stainless Steel Couplings: Neoprene sleeve gasket, 0.015" thick 304 stainless steel shield, stainless steel 3/8" screw type clamps, minimum of four clamps for 1-1/2" to 4" and six clamps for 5" and larger pipe sizes. Clamps shall be tightened to minimum 80 inch pounds or as manufacturer requires. Husky SD-4000 or equal.
4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 310. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.
5. Adapters: Transition from cast iron soil pipe to other pipe materials with manufactured adapters specifically for the application. Adapter must meet the same requirements as the joints listed above. ASTM C1460. Sticker identifying transition fitting application must be visible to view. For example, the most commonly used transition fitting from cast iron no-hub to PVC would be the Husky SD-4200 series.

2.2 COPPER PIPE

A. Copper Pipe; Type L; Solder Joints:

1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
2. Design Pressure: 175 psi; Maximum Design Temperature: 200F.
3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
4. Fittings: Wrought copper solder joint, ANSI B16.22.

B. Copper Pipe; Type L; Mechanical Press Connection:

1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
2. Design Pressure: 175 psi; Maximum Design Temperature: 200F.
3. Joints: Mechanical press connection.
4. Fittings: Copper, ANSI B-16.22, with embedded EPDM O-ring / sealing element engineered for this application, NSF-61.
5. Fitting Identification: Press ends shall provide the ability to identify an unpressed fitting from the floor prior to testing. The function of this feature is to provide the installer quick and easy identification of connections that have not been pressed prior to putting the system into operation.

6. Special Requirements: Mechanical press fitting manufacturer shall provide Contractor training prior to installation.
7. Manufacturers:
 - a. Viega ProPress
 - b. Apollo Press, a division of Aalberts - IPS
 - c. NIBCO Press System Fittings and Valves
 - d. Merit Brass
 - e. Mueller Streamline PRS

C. Copper Pipe: Type DWV; Solder Joints:

1. Pipe: Type DWV hard temper seamless copper drainage tube, ASTM B306.
2. Design Pressure: Gravity Maximum Design Temperature: 180F.
3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
4. Fittings: Cast brass solder joint drainage type, ANSI B16.23 or wrought copper solder joint drainage type, ANSI B16.29.

2.3 PLASTIC PIPE

A. Cross-Linked Polyethylene (PEX); Cold Expansion Joint:

1. Pipe: Cross-linked polyethylene (PEX-a or PEX-b), SDR-9, ASTM F876, NSF Certified, manufacturer approved for cold expansion fittings ASTM F1960.
2. Design Pressure/Temperature: 100 psig at 180F.
3. Joints: Bending the pipe greater than eight (8) times the outside diameter shall be permitted. Bends less than eight (8) times the outside diameter shall be barbed insertion fittings provided by the manufacturer.
4. Fittings: Cold expansion joint compatible with engineered polymer construction. System shall conform to ASTM F1960.
5. Limitations: Shall not be used in a return air plenum unless specifically listed to ASTM E84/UL723.

2.4 VALVES

A. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Ball Valves:
 - a. BA-1: 3" and under, 150 psi saturated steam, 600 psi CWP, full port, threaded or solder ends (acceptable only if rated for soldering in line with 470F melting point of lead-free solder), stainless steel ball and trim, Teflon seats and seals.

- 1) Body: Lead free NSF-372, two-piece bronze of a copper alloy containing less than 15% zinc. Apollo Valves; a division of Aalberts–IPS #77CLF140/240 Series, Milwaukee #UPBA450S, Watts #LFB6080G2-SS, NIBCO #T-585-66-LF, Jomar T-200CSSG.
- 2) Body: Dezincification resistant brass alloy, lead free NSF-372. Jomar T-100CSSG.
- 3) Provide solid extended shaft for all insulated piping. (For example, Apollo adds option -04 Stem Extension, NIBCO Nib-Seal Handle-NS, and Jomar modifies valve part number with -IH for insulated handle.)
- 4) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120F, heating water piping over 120F, steam, condensate, boiler feed water piping, and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lockout trim. (For example, Jomar and NIBCO modify valve part number with -LH for locking handle.)

2.5 STRAINERS

- A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. ST-1: Threaded Ends, 4" and under, lead free bronze or 304 stainless steel body, threaded connections, threaded removable cover, 0.045" 304 stainless steel perforated screen, 125 psi S at 350F, 200 psi CWP at 150F. Apollo Valves, a division of Aalberts-IPS YB-LF (59LF), Metraflex SSFT, Mueller / Watts LF351, Watts LF777, Jomar T-651G, Zurn SXL.

2.6 CHECK VALVES

- A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. CK-1: Threaded Ends, 2" and under, 125 psi steam at 406F, 200 psi CWP at 150F, threaded connection, lead free bronze body with brass or bronze disc, horizontal swing. Hammond #UP904, Milwaukee #UP509, NIBCO T-413-Y-LF, Jomar T-511G, Apollo Valves, a division of Aalberts-IPS #161T-LF.

2.7 LOCK OUT TRIM

- A. Provide lock out trim for all quarter turn shutoff valves opening to atmosphere and installed in domestic water piping over 120F and as indicated on the drawings.

2.8 VALVE OPERATORS

- A. Provide handwheels for gate valves and gear operators for butterfly valves.

2.9 VALVE CONNECTIONS

- A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

2.10 CONNECTIONS BETWEEN DISSIMILAR METALS

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel and stainless steel are commonly used and require isolation from each other with the following exceptions:
 - 1. Iron and steel connected to each other.
 - 2. Brass, copper, and bronze connected to each other.
 - 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed and/or Grooved Joints (acceptable up to 4" size):
 - 1. Dielectric waterway rated for 300 psi CWP and 225F.
 - 2. Optional: Copper-silicon casting conforming to UNS C87850 with grooved and/or threaded ends.
 - 3. UL classified in accordance with ANSI / NSF-61 for potable water service.
 - 4. Manufacturers:
 - a. Elster Group ClearFlow fittings
 - b. Victaulic Series 647
 - c. Grinnell Series 407
 - d. Matco-Norca
- F. Flanged Joints (any size):
 - 1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
 - 2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
 - 3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
 - 4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.

5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
6. Manufacturers:
 - a. EPCO
 - b. Central Plastics
 - c. Pipeline Seal and Insulator
 - d. F. H. Maloney
 - e. Calpico

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install all products per manufacturer's recommendations.
- B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- C. Remove scale and dirt, on inside and outside, before assembly.
- D. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- E. Connect to equipment with flanges or unions. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.
- F. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.
- G. Roof Penetration (Vent) Flashing:
 1. Built-up Roofing: Flash vents with 3# seamless sheet lead of sufficient size to extend 15" into roofing felts for built-up roofs.
- H. Existing building sewers or building drains which are shown on the documents to be reused shall be inspected and recorded by closed circuit television for their condition. Report findings back to the Architect, Engineer, and Owner before proceeding with work so any necessary rework can take place if needed.

3.2 SYSTEM, PIPING AND VALVE SCHEDULE

- A. The schedule below lists acceptable pipe and valve materials for each plumbing system type. Refer to the paragraph of the same name above in Part 2 for material specifications and limits for usage. This schedule is kept brief to simplify the information but shall not be interpreted to contradict limitations in Part 2. For example, if PVC/ABS is listed for sanitary waste and vent above ground in this schedule, that does not mean it is universally allowed for the entire project. Rather the material is still limited by Part 2 and is not allowed in return air plenum space.s

- B. Cold Water, Hot Water, Tempered Water, Reclaimed Water - Potable and Non-Potable (Above Ground):
 - 1. Copper Pipe; Type L; Solder Joints: All Sizes
 - 2. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
 - 3. Shutoff Valves: BA-1
 - 4. Check Valves: CK-1
 - 5. Strainers: ST-1
- C. Pure Water:
 - 1. Cross-Linked Polyethylene (PEX); Cold Expansion Joint: 3" and Under
- D. Sanitary Waste and Vent, Gravity (Above Ground):
 - 1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15" Copper Pipe: Type DWV; Solder Joints: 1-1/4" to 4"
- E. Sanitary Indirect Drainage (Above Ground):
 - 1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15" Copper Pipe: Type DWV; Solder Joints: 1-1/4" to 4"
- F. Storm Drainage, Clear Water Waste and Vent, Gravity (Above Ground):
 - 1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
 - 2. Copper Pipe: Type DWV; Solder Joints: 1-1/4" to 4"
- G. Sanitary Waste and Vent, Gravity (Underground - Inside Building):
 - 1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
- H. Storm Drainage, Clear Water Waste and Vent, Gravity (Underground - Inside Building):
 - 1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes

3.3 TESTING PIPING

- A. Sanitary Drainage, Sanitary Vent, Storm Drainage:
 - 1. Test all piping with water to prove tight.
 - 2. Test piping before insulation is applied.
 - 3. Hydrostatically test all soil, waste, and vent piping inside of building with 10 feet head of water for 15 minutes. Inspect before fixtures are connected. If leaks appear, repair them and repeat the test.
 - 4. Hydrostatically test interior downspouts with 10 feet head of water for 15 minutes with no leaks.
 - 5. A smoke/air test at the same pressure may be used in lieu of the hydrostatic water test. Exception: Smoke/air test shall not be performed on plastic piping.
 - 6. Test force mains with water at 105% of the operating pump discharge pressure for 15 minutes.

7. Test pressures stated above shall be as listed or as required by the Authority Having Jurisdiction, whichever is most stringent.
- B. Hot Water - Potable and Non-Potable, Cold Water - Potable and Non-Potable:
1. Test pipes underground or in chases and walls before piping is concealed.
 2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.
 3. Test the pipe with 100 psig water pressure or equal inert gas such as nitrogen. Exception: Inert gas test shall not be used to test plastic piping.
 4. Hold test pressure for at least 2 hours.
 5. Test to be witnessed by the Architect/Engineer's representative, if requested by the Architect/Engineer.
- C. Fire Service:
1. Hydrostatically test the entire system for two hours at 200 psig. Maximum leakage shall be:
 - a. Interior Piping: 0 quarts per hour.
 - b. Underground Piping: 2 quarts per 100 joints per hour.
- D. Vacuum Piping:
1. Testing pipes in chases, walls, or above non-accessible ceilings before piping is concealed.
 2. Test with 100 psig compressed air or nitrogen.
 3. During the test, strike all soldered joints sharply with a rubber or rawhide mallet to cause failure of any weak joints. After striking, soap test each joint.
 4. Repair and retest all leaking joints.
 5. After all joints pass the soap test, the system must maintain test pressure for 24 hours. If system fails the 24-hour, retest ALL joints by resoaping and repair all faulty joints. Repeat this procedure until the test pressure can be maintained for 24 hours.
 6. After passing the above test, operate the vacuum pump. With all vacuum valves closed, the pump and piping system shall be able to maintain a vacuum of 25" Hg for at least one hour.
 7. All materials, labor and equipment for testing shall be provided by the installing Contractor.
 8. Tests to be witnessed by the Architect/Engineer's representative, if requested by the Architect/Engineer.
 9. After testing, seal the complete system against entry of foreign material until it is turned over to the Owner.
- E. All Other Piping:
1. Test piping at 150% of normal operating pressure.
 2. Piping shall hold this pressure for one hour with no drop in pressure.
 3. Test piping using water, nitrogen, or air as compatible with the final service of the pipe. Do not use combustible fluids.

4. Drain and clean all piping after testing is complete.

3.4 CLEANING PIPING

A. Assembly:

1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer's representative. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Notify the Architect/Engineer's representative before starting any post erection cleaning in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer's representative regarding specific procedures and scheduling. Dispose of cleaning and flushing fluids properly.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

B. Air Blow:

1. Blow out pipe and components with clean compressed air. Instrument air, argon, nitrogen and sulfuric acid lines shall be blown out with dry, oil free air or nitrogen gas. "Oil Free" is defined as air compressed in a centrifugal, Teflon ring, carbon ring or water pumped air compressor. Where air supply is judged to be inadequate to continually attain cleaning velocity, alternate pressurization and sudden relief procedure may be used until discharge at all blow out points is clean. Use 80-90 psig pressure unless otherwise indicated.
2. Air blow applies to the following systems:
 - a. Acetylene
 - b. Carbon Dioxide
 - c. Nitrogen (use oil free air or nitrogen gas)
 - d. Argon (use oil free air or nitrogen gas)
 - e. Instrument Air (use oil free air or nitrogen gas)
 - f. Distilled Water (use maximum of 50 psig pressure)
 - g. Chemical Feed
 - h. Air Compressor Intakes
 - i. Sulfuric Acid (use oil free air or nitrogen gas)

C. All Water Piping:

1. Flush all piping using faucets, flush valves, etc. until the flow is clean.
2. After flushing, thoroughly clean all inlet strainers, aerators, and other such devices.
3. If necessary, remove valves to clean out all foreign material.

D. Fire Service:

1. Flush all underground piping with minimum flow equal to the system design flow but not less than the following:
 - a. 390 gpm for 4" pipes.
 - b. 880 gpm for 6" pipes.
 - c. 1560 gpm for 8" pipes.
 - d. 2440 gpm for 10" pipes.
 - e. 3500 gpm for 12" pipes.

3.5 INSTALLATION

A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Slope water piping and arrange to drain at low points.
6. Install bell and spigot piping with bells upstream.
7. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
8. Seal pipes passing through exterior walls with a wall seal per Section 220529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
9. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.
10. All vertical pipe drops to sinks or other equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.

B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

C. Installation Requirements in MRI (Magnetic Resonance Imaging - Healthcare):

1. All piping in MRI rooms shall be non-ferrous regardless of materials described on Part 2.

D. Valves/Fittings and Accessories:

1. Install shutoff valves that permit the isolation of equipment/fixtures in each room without isolating any other room or portion of the building. Individual fixture angle stops do not meet this requirement. Exception: Back-to-back rooms in no more than two adjacent rooms.
2. Provide clearance for installation of insulation and access to valves and fittings.
3. Provide access doors for concealed valves and fittings.
4. Install valve stems upright or horizontal, not inverted.
5. Provide one plug valve wrench for every ten plug valves 2" and smaller, minimum of one. Provide each plug valve 2-1/2" and larger with a wrench with set screw.
6. Install corrugated, stainless steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

E. Underground Piping:

1. Refer to Section 220500 for Excavation, Fill, Backfill and Compaction requirements
2. Install buried borosilicate glass pipe with the protective polystyrene covering intact. Lay the pipe on bedding and backfill per manufacturer instructions.
3. Install thrust blocking and restraints on all underground fire protection service piping per NFPA 24 and as shown on drawings.
4. Install underground, sleeved, corrugated, stainless steel tubing system according to manufacturer's written instructions. Extend vent from sleeve to exterior of building and terminate with screened elbow.
5. Direct buried, uninsulated steel pipe shall have a factory applied external protective coating consisting of two coats with an intermediate layer of 18 mil fibrous glass mat. Coating thickness shall total not less than 3/32". The outer coating shall be further protected by a wrapping of heavy Kraft paper. This external protection shall extend and be exposed for a minimum of 1 foot beyond the buried or concealed portion of the pipe.

a. Manufacturers:

- 1) Pipe Line Service Co., Franklin Park, Illinois
- 2) Lithcote Corp., Melrose Park, Illinois

6. As an option, the Contractor may provide factory applied protective coatings consisting of a polyethylene plastic film bonded to the pipe surface by a hot applied thermo-plastic adhesive.

a. Manufacturers:

- 1) Republic Steel Corp. "X-Tru-Coat"

7. Exercise care in handling, storing and laying pipe to avoid damaging factory applied coatings. If any damage occurs, repair the coating to a condition equal to the original.

8. Field application of protective coatings to joints, fittings and to any damaged factory applied coatings shall be similar to factory applied coatings specified above and shall be done in strict accordance with recommendations of the supplier of pipe coatings.
9. After completion of the fabrication, laying and field coating of the joints and fittings, but prior to backfilling, inspect the entire line in the presence of the Architect/Engineer's representative with an electronic holiday detector. Any defects in the protective coatings shall be repaired in accordance with requirements for original coatings.
10. Coat flange bolts and nuts in pits and below ground at the time of installation with a corrosion protective coating.

F. Sanitary and Storm Piping:

1. Install all sanitary and storm piping inside the building with a slope as shown on the drawings.
2. Install horizontal offset at all connections to roof drains to allow for pipe expansion.
3. Slope sanitary and storm piping outside the building to meet invert elevations shown on drawings and to maintain a minimum velocity of 2 feet per second.
4. Sway Bracing: Where horizontal sanitary and/or storm pipes 4 inches and larger change flow direction greater than 45 degrees, rigid bracing or thrust restraints shall be installed to resist movement of the upstream pipe in the direction of pipe flow. The rigid bracing or thrust restraint shall be connected to structure. A change of flow direction from horizontal into a vertical pipe does not require the upstream pipe to be braced.
5. Starter fittings with internal baffles are not permitted.

3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.
- B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.
- D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.
- E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.

- F. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.
- G. Provide flanges or unions at all final connections to equipment, traps and valves.
- H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.
- I. Use full and double lengths of pipe wherever possible.
- J. Unless otherwise indicated, install all piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or equipment.
- K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- L. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Refer to Section 220500 for Excavation, Fill, Backfill and Compaction requirements.
- M. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45-degree or 90-degree angle from the horizontal plane for air lines, and from top, bottom or side for liquids.
- N. Do not use geotextile fabric with footing tile if silt content of soil exceeds 40% or if clay content exceeds 50%. The fabric shall be installed around 1" river rock or 2" limestone.

3.7 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal water lines, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate and venting.
- B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.
- C. Provide drain valves at all low points of water piping systems for complete or sectionalized draining.
- D. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.
- E. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.

- F. Install air vents in accessible locations. If necessary to trap and vent air in a remote location, install an 1/8" pipe from the tapping location to an accessible location and terminate with a venting device.
- G. All vent and drain piping shall be of same materials and construction for the service involved.

3.8 PLUMBING VENTS

- A. Vent as shown on the drawings and in accordance with all codes having jurisdiction.
- B. Extend the high side of the soil and waste stacks at least 12" above roof.
- C. Flash pipes at the roof with 3# lead sheet. Extend flashing under roofing 15" in all directions from pipe to be flashed. Extend a lead collar up on the outside of pipe to be flashed and extend 1" beyond the top of the pipe. The 1" excess length of collar shall be turned down into the top of the pipe where it shall fit tight to the inside of the pipe.
- D. Flash pipes at roof with premolded EPDM pipe flashing cones adhered to roof membrane by General Contractor. Secure top of cone with stainless steel clamp and seal watertight.
- E. Increase vent pipes through the roof two pipe sizes with long increasers located at least 12" below the roof.
- F. In no case shall the vent through the roof be less than 4" in diameter.
- G. Vent pipes through the roof shall be located a minimum of 25 feet from any air intake opening on the roof.

3.9 BRANCH CONNECTIONS

- A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.
- B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- C. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.
- D. Branch connections from the headers and mains may be mechanically formed using an extraction device. The branch piping connection shall be brazed connection for the following services only:
 - 1. Domestic water piping above ground.
- E. Further limit use of mechanically formed fittings as follows:
 - 1. Must have at least same pressure rating as the main.
 - 2. Main must be Type K or L copper tubing.
 - 3. Permanent marking shall indicate insertion depth and orientation.

4. Branch pipe shall conform to the inner curve of the piping main.
5. Main must be 1" or larger.
6. Branch must be 3/4" or larger.

F. Forged weld-on fittings are limited as follows:

1. Must have at least same pressure rating as the main.
2. Main must be 2-1/2" or larger.
3. Branch line is at least two pipe sizes under main size.

3.10 JOINING OF PIPE

A. Solder Joints (Copper Pipe):

1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
2. Flux shall be non-acid type.
3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470F melting point solder. Remove discs and seals during soldering if they are not suitable for 470F.

B. Mechanical Press Connection (Copper and Stainless Steel Pipe):

1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
2. Fully insert tubing into the fitting and mark tubing.
3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
4. Joint shall be pressed with a tool approved by the manufacturer.
5. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

C. Hub and Spigot Joints - Sanitary Pipe and Storm Pipe (Cast Iron and Stainless Steel Pipe):

1. Lead and Oakum Joints: Pack joint with oakum made of vegetable fiber, cotton, or hemp. Pour joint with molten lead up to top of hub. Ensure leak-free joints by working joint with inside and outside caulking irons.
2. Compression Gasket Joints: Joint shall be one-piece double seal compression type gasket made specifically for joining cast iron soil pipe. Gasket shall be neoprene, permitting joint to flex as much as 5 degrees without loss of seal. Gasket shall be extra heavy weight class, conforming to ASTM C-564.

D. Cold Expansion Joint (PEX):

1. Cold expansion joints shall be made in accordance with manufacturer's installation instructions.

2. All installers shall undergo training provided by the manufacturer or manufacturer's representative.
- E. No-Hub Sleeve Gaskets (No-Hub) (Cast Iron Pipe):
1. Gasket shall be heavy weight class, conforming to ASTM C564.
 2. The gasket shall have an internal center stop.
 3. The gasket shall be covered by a stainless steel band secured with a minimum of four stainless steel bands per fitting/joint.
 4. Sleeve gaskets shall be installed in accordance with the manufacturer's installation instructions.
- F. Couplings: Assemblies with combinations of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.
- G. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.
- H. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.
- 3.11 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM
- A. Disinfection of the domestic water piping shall be completed within three (3) weeks prior to building occupancy. Contractor is responsible for disinfecting water piping if used by workers during construction; disinfection during construction does not eliminate the requirement for final disinfection prior to occupancy. Flushing of piping shall be completed within two (2) weeks prior to building occupancy.
- B. Provide necessary connections at the start of individual sections of mains for adding chlorine.
- C. Before starting work, verify system is complete, flushed and clean.
- D. Follow the disinfection of potable water procedure outlined in this project's applicable plumbing code. For example: IPC 610.1, UPC 609.10, CPC 609.10, and Illinois 890.1180. Where local codes do not outline a disinfection procedure, follow the International Plumbing Code procedure 610.1.
- E. Bleed water from all outlets to ensure chlorine distribution throughout the entire domestic water system.
- F. Take water samples, no sooner than 24 hours after flushing, from 2% of outlets and from water entry. Obtain, analyze, and test samples in accordance with AWWA C651, Section 5 - Verification.

3.12 SERVICE CONNECTIONS

- A. Provide new water service with water meter with bypass valves. Provide sleeve in wall for service main per Section 220529.

END OF SECTION

SECTION 221030 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleanouts.
- B. Traps.
- C. Trap Seals and Primers.
- D. Floor Drains and Sinks
- E. Backflow Preventers.
- F. Strainers.
- G. Unions.
- H. Balancing Valves.
- I. Water Hammer Arresters.
- J. Dielectric Fittings (Connections Between Dissimilar Metals).
- K. Air Vents.
- L. Drain Valves.
- M. Relief Valves.

1.2 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
- B. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 220500.
- B. Include sizes, rough-in requirements, service sizes, and finishes.
- C. Manufacturer shall provide special seismic certification per HCAi CAN 2-1708a.5 with submittal. Submittals without certification will be returned and not reviewed.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Provide cleanouts as shown and specified on the drawings as well as required by code.
- B. Coordinate floor cleanout cover with surrounding floor finish. Provide either solid, recessed for tile or terrazzo or carpet marker as applicable.
- C. Cleanouts on exposed pipes shall be cast iron with heavy duty cast brass plug with raised head.
- D. Cleanout shall be same size as the pipe up to 6" and 6" for larger pipes.

2.2 TRAPS

- A. Provide all individual connections to the sanitary system with P-traps, except where such drains discharge directly into a properly trapped collection basin or sump. Unless otherwise specified or shown, traps shall be of the same material as specified for waste system.
- B. All traps shall have accessible, removable cleanouts, except where installed on floor drains with removable strainers.
- C. Deep seal pattern traps shall be provided where required by code.
- D. Each trap shall be completely filled with water at the end of construction but before building turnover to the Owner. All floor drains, floor sinks, trench drains, etc. shall be filled with water.

2.3 TRAP SEALS AND PRIMERS

- A. Provide trap primers as shown and specified on the drawings.
- B. Where trap primers are shown on drawings, coordinate with corresponding floor drains to ensure they include a side inlet connection for the trap primer line.

2.4 FLOOR DRAINS AND SINKS

- A. Floor drains and sinks shall be in the form of a receptor with grate/strainer set flush with the surrounding floor.
- B. Provide floor drains and sinks as shown and specified on the drawings as well as required by code.

2.5 BACKFLOW PREVENTERS

- A. Provide backflow preventers as shown and specified on the drawings as well as required by code.

2.6 STRAINERS

- A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:
 - 1. Water:
 - a. 1/4" - 2": 3/64" perforations
 - b. 2-1/2" - 10": 1/16" perforations
 - c. 12" - 18": 1/8" perforations
- B. Furnish pipe nipple with shutoff valve to blow down all strainer screens.
- C. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

2.7 UNIONS

- A. Copper pipe - wrought copper fitting - ground joint.
- B. Black Steel (Schedule 40) Pipe - malleable iron, ground joint, 150 psi, bronze to bronze seat.
- C. Galvanized Steel Pipe - galvanized malleable iron, ground joint, 150 psi, bronze to bronze seat.

2.8 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units which sense pressure across a valve). Graph shall extend below the specified minimum flow.
- C. Furnish one meter kit equivalent to Bell & Gossett Model RO-5 meeting the following requirements:
 - 1. Carrying case with handle.
 - 2. Pressure gauge with 0-25 feet of head scale with 3.0% full scale accuracy.
 - 3. High and low side hoses with 5 feet length and 250 psig pressure rating, equipped with shutoff valves, vent valves, and probes for insertion into pressure and temperature plugs.
 - 4. Coordinate with the Mechanical Contractor if a meter kit is also required in Section 232100. It is not our intent to require two identical kits, rather it will be acceptable to provide only one kit to the owner which can be used with both plumbing and hydronic piping systems.

- D. Flow rate of 0.5 GPM or larger: Valves in copper piping shall be brass or bronze. Acceptable Manufacturers: Flow Design "Accusetter", Preso "B+", Armstrong "CVB", Bell & Gossett "Circuit Setter Plus", Griswold "Quickset", Gerand "Balvalve Venturi", Nibco Globe Style or Hays MV7-005 balancing valve.
- E. Flow rate less than 0.5 GPM: Valves in copper piping shall be brass or bronze. Cv value shall be less than 1.0 when valve is completely open, and minimum balanceable flow rate shall not exceed 0.1 GPM with a meter reading of at least 2.5 feet. Acceptable manufacturers: Bell & Gossett "Circuit Setter RF", Flow Design, Preso, Armstrong, Griswold, Gerand, or Nibco balancing valve.
- F. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.9 WATER HAMMER ARRESTERS

- A. Provide water hammer arresters as shown and specified on the drawings as well as required by code.
- B. ANSI A112.26.1; sized and located in accordance with PDI WH-201, precharged for operation between -100F and 300F and maximum 250 psig working pressure.

2.10 DIELECTRIC FITTINGS (CONNECTIONS BETWEEN DISSIMILAR METALS)

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:
 - 1. Iron, steel, and stainless steel connected to each other.
 - 2. Brass, copper, and bronze connected to each other.
 - 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
 - 1. Dielectric waterway rated for 300 psi CWP and 225F.
 - 2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic Series 47, Grinnell Series 407, Matco-Norca.

F. Flanged Joints (any size):

1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

2.11 AIR VENTS

- A. Provide means for venting air at all high points in the piping system and at all other points where air may be trapped.
- B. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

2.12 DRAIN VALVES

- A. Drain valves shall be shutoff valves as specified for the intended service with added 3/4" male hose thread outlet and cap.

2.13 RELIEF VALVES

- A. RV-3: (Compressed Air) Spring loaded disc type, cast iron or steel body, stainless steel disc, side outlet and lifting lever, 250# CWP. Acceptable Manufacturers: Consolidated Div. of Dresser Ind. Series 1900, Kunkle #463, Keckley Type 41.
- B. RV-4: (Domestic Hot Water) Pressure and Temperature relief, cast bronze body and internal parts, stainless steel spring, test lever, threaded inlet and outlet. Maximum setting of 150 psi and 210F temperature. Capacities ASME certified and labeled. Acceptable Manufacturers: Cash Series FV, Watts #40, #120, #N240, #340.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

- A. Coordinate construction to receive drains at required invert elevations.
- B. Install all items per manufacturer's instructions.

C. Water Hammer Arresters:

1. Install water hammer arresters in accessible locations. Provide access doors as required. Coordinate type with Architect/Engineer/Owner.
2. Water hammer arrestors shall be installed in cold and hot water lines upstream of all plumbing fixtures or equipment, with a quick acting valve or multiple quick acting valves. Quick acting valves shall be defined as solenoid actuated valves, manual flush valves, sensor activated faucets and flush valves, squeeze handle spray faucets, and other similar type valves.
3. Install multiple water hammer arrestors in toilet group branch piping greater than 20 feet in developed length from the cold and hot water mains.

D. Floor Drains and Floor Sinks:

1. Drains in upper floors shall have a flashing of EPDM or similar membrane sheet. The sheet shall be at least 36" X 36" square with the drain in the center. Clamp membrane in auxiliary clamping ring of floor drain.
2. Use alternate sealing method when installing drains in existing floor slabs.
3. Coordinate sloping requirements with the architectural plans and specifications.
4. Top of floor drain and sink grate/strainer shall not extend above the finished floor elevation. Grate/strainer shall be installed flush with surrounding finished floor. Should the Plumbing Contractor believe this presents a conflict with code, the issue should be evaluated before installation of the floor drain or sink begins. Proceeding with installing a floor drain or sink raised above the finished floor without prior approval will result in the Contractor being required to remove the drain or sink in question and reinstall it at the approved elevation.

E. Backflow Preventer:

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer's instructions and applicable codes by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor in a location that is accessible for annual testing and maintenance.

F. Balancing Valves:

1. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.

END OF SECTION

SECTION 230500 - BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 23 Sections. Also refer to Division 01 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours will be required.
- B. Itemize all work and list associated hours and pay scale for each item.

1.3 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
 - a. Plumbing Contractor.
 - b. Heating Contractor.
 - c. Air Conditioning and Ventilating Contractor.
 - d. Temperature Control Contractor.
 - e. Fire Protection Contractor.
 - f. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.

5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
 - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.

5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
 - a. Light fixtures.
 - b. Gravity flow piping, including steam and condensate.
 - c. Electrical busduct.
 - d. Sheet metal.
 - e. Electrical cable trays, including access space.
 - f. Sprinkler piping and other piping.
 - g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
 - a. Boiler Feed Pumps.
 - b. Burners.
 - c. Chillers.
 - d. Computer Room Air Conditioning Units.
 - e. Condensate Return Stations.
 - f. Condensing Units.
 - g. Makeup Air Units.
 - h. Electric Humidifiers.
 - i. Gas Trains.
 - j. Package Air Handling Units.
 - k. Packaged Rooftop Units.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
 - a. Wiring of all devices needed to make the Temperature Control System functional.
 - b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
 - c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.4 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.

- a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
 3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
- B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
 2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
 3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
 2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
 3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.

4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect/Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Architect/Engineer and Owner's Representative. The Architect/Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The Architect/Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect/Engineer.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the Architect/Engineer at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect/Engineer and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.5 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Rogers, AR Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all published standards of Mercy.
3. Conform to all State Codes.
4. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
6. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
7. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
8. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriters' Laboratories, Inc. and approved by FM Global.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. Make application for and pay for service connections, such as gas.
4. Make application for and pay for all meters and metering systems required by the utility company.

F. Examination of Drawings:

1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.

- a. Any item listed as furnished shall also be installed, unless otherwise noted.
- b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

- 1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

- 1. Construction drawings for this project have been prepared utilizing Revit.
- 2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
- 3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
- 4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
- 5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
- 6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
- 7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
- 8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.6 WEB-BASED PROJECT SOFTWARE

- A. The General Contractor shall provide a web-based project software site for the purpose of hosting and managing project communication and documentation until completion of the warranty phase.
- B. The web-based project software shall include, at a minimum, the following features: construction schedule, submittals, RFIs, ASIs, construction change directives, change orders, drawing management, specification management, payment applications, contract modifications, meeting minutes, construction progress photos.
- C. Provide web-based project software user licenses for use by the Architect/Engineer. Access will be provided from the start of the project through the completion of the warranty phase.
- D. At project completion, provide digital archive of entire project in format that is readable by common desktop software applications in format acceptable to Architect/Engineer. Provide data in locked format to prevent further changes.

1.7 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals List:

Referenced Specification Section	Submittal Item
23 05 00	Owner Training Agenda
23 05 03	Fire Seal Systems
23 05 13	Motors
23 05 48	Vibration Isolation Equipment
23 05 50	Seismic Restraint Systems
23 05 93	Testing, Adjusting, and Balancing
23 09 00	Controls
23 09 13	Instrumentation
23 21 23	HVAC Pumps
23 84 13	Humidifiers
23 31 00	Ductwork Layout Drawings
23 33 00	Duct Silencers
23 33 00	Fire Dampers
23 33 00	Smoke Dampers
23 33 00	Combination Fire Smoke Dampers
23 34 16	Centrifugal Fans
23 36 00	Terminal Air Boxes
23 37 00	Grilles, Registers, and Diffusers
23 40 00	Filters and Filter Systems

23 72 00
23 74 13

Energy Recovery Devices
Rooftop Modular Air Handling Units

- B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:
1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
 2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
 3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
 4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
- b. Unstamped submittals will be rejected.
- c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
- d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
- e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions, or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 23 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 23 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.8 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 01.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:
 - a. Material: Delivered cost of product with taxes paid.
 - b. Labor: Labor cost, excluding overhead and profit.
3. Itemize the cost for each of the following:
 - a. Overhead and profit.
 - b. Bonds.
 - c. Insurance.
 - d. General Requirements: Itemize all requirements.
4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
 - a. Each piece of equipment requiring shop drawings (e.g., each air handling unit, pump, exhaust fan, etc.). Use the equipment nomenclature (AHU-1, P-1, EF-1, etc.) on the Schedule of Values.
 - b. Each type of small unitary equipment (e.g., FCUs, UHs, CABs, etc.). Multiple units of the same type can be listed together, provided quantities are also listed so unit costs can be determined.
 - c. Each piping system (chilled water, heating water, steam, condensate, etc.). In addition, for larger projects, break down the material and labor for each piping system based on geography (building, floor, and/or wing).
 - d. Each duct system (supply, return, relief, outside air, etc.) listed separately for each unit they serve (AHU-1 supply air ductwork, AHU-1 return air ductwork, etc.).
 - e. Pipe insulation with separate material and labor line items for each piping system listed above.
 - f. Duct insulation with separate material and labor line items for each duct system listed above.
 - g. Temperature controls broken down into material and labor for the following:
 - 1) Engineering
 - 2) Controllers, devices, sensors, etc.
 - 3) Control valves
 - 4) Control dampers
 - 5) Conduit

- 6) Wiring
- 7) Programming
- 8) Commissioning

- h. Site utilities (5' beyond building)
- i. Seismic design
- j. Air balancing
- k. Water balancing
- l. Commissioning
- m. Record drawings
- n. Punchlist and closeout

D. Update Schedule of Values when:

- 1. Indicated by Architect/Engineer.
- 2. Change of subcontractor or supplier occurs.
- 3. Change of product or equipment occurs.

1.9 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
 - 1. Air Cooled Condensers
 - 2. Base Mounted Pumps
 - 3. Boilers, Burners and Boiler Trim
 - 4. Computer Room Units
 - 5. Condensing Units
 - 6. Cooling Towers
 - 7. Gas Fired Makeup Air Units
 - 8. Fire Seal Systems
 - 9. Fluid Coolers
 - 10. Seismic Restraints and Equipment Bracing
 - 11. Vibration Isolation
 - 12. Water Chillers

- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Protect equipment, components, and openings with airtight covers and exercise care at every stage of storage, handling, and installation of equipment to prevent airborne dust and dirt from entering or fouling equipment to include, but not limited to:
 - 1. Motor windings and ventilation openings.
 - 2. Bearings.
 - 3. Equipment Pipe and Accessories connections openings. (e.g. boiler connections, coil connections, etc.)
 - 4. Equipment Duct and Accessories connections openings. (e.g. AHU/RTU duct connections; Terminal Air Boxes, etc.)
 - 5. Starter and control cabinets.
 - 6. Heat transfer coils.
 - 7. Pump Seals.
 - 8. Combustion burner and blower equipment (e.g. combustion air intake, combustion vent/flue, etc.)
- C. Equipment and components that are visibly damaged or have been subject to environmental conditions prior to building turnover to Owner that could shorten the life of the component (for example, water damage, humidity, dust and debris, excessive hot or cold storage location, etc.) shall be repaired or replaced with new equipment or components without additional cost to the building owner.
- D. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- E. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, they shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- F. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.14 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.15 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

1.16 PROJECT COMMISSIONING

- A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 23 08 00 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

- A. General:
 - 1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (<https://call811.com/>) or by calling 811.
 - 2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.

3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
 1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
 - a. Pipe insulation is installed and fully sealed.
 - b. Pipe and duct wall penetrations are sealed.
 - c. Pipe identification and valve tags are installed.
 - d. Main, branch and flexible ducts are installed.
 - e. Diffusers, registers and grilles are installed and connected to ductwork.
 - f. Terminal air box reheat coil piping or wiring is complete.
 - g. Terminal air box control wiring is complete and all control boxes are closed.
 2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
 3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 01.
- B. Final Jobsite Observation:
 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
 3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
 4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, this Contractor must submit the following:
 1. Operation and maintenance manuals with copies of approved shop drawings.

2. Record documents including marked-up or reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Inspection by State Boiler Inspector.
5. Start-up reports on all equipment requiring a factory installation inspection or start-up.
6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div23.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Refer to Section 230900 for additional requirements for Temperature Control submittals.
5. Copy of final approved test and balance reports.
6. Copies of all factory inspections and/or equipment startup reports.
7. Copies of warranties.
8. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
9. Dimensional drawings of equipment.
10. Capacities and utility consumption of equipment.
11. Detailed parts lists with lists of suppliers.
12. Operating procedures for each system.
13. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
14. Repair procedures for major components.
15. List of lubricants in all equipment and recommended frequency of lubrication.
16. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

E. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Explanation of all air handling systems.
3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
4. Maintenance of equipment.
5. Smoke control systems.
6. Stairwell pressurization systems.
7. Start-up procedures for all major equipment.
8. Explanation of seasonal system changes.
9. Description of emergency system operation.

F. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

G. Minimum hours of instruction for each item shall be:

1. Humidification System - 4 hours.
2. Air Handling System(s) - 4 hours.
3. Dehumidification System - 4 hours.
4. Exhaust System(s) - 4 hours.
5. Temperature Controls - As defined in Section 230900.

H. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

I. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM STARTING AND ADJUSTING

A. The mechanical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.

- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels.
- D. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- E. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- F. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 01 requirements.
- B. Maintain at the job site a separate and complete set of mechanical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- D. Refer to Section 230900 for additional requirements for Temperature Control documents.
- E. Before completion of the project, a set of reproducible mechanical drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.

- F. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- G. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- H. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.9 PAINTING

- A. This Contractor shall paint the following items:
 - 1. All piping in mechanical room
 - 2. Piping exposed in kitchen
- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.
- D. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.
- F. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- G. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
 - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
 - 2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.

3. Color of paint shall be as follows:

a. All piping in mechanical room:

- 1) Chilled Water: Blue pipe/black letters
- 2) Condenser Water: Green pipe/black letters
- 3) Heating Water: Orange pipe/black letters
- 4) Natural Gas: Yellow pipe/black letters

b. Piping exposed in kitchen:

- 1) All Piping: White

3.10 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed bare metal ductwork, piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.11 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.12 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
 1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
 - a. Minimizing the amount of dust generated.
 - b. Reducing solvent fumes and VOC emissions.

- c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
 - d. Protect stored on-site and installed absorptive materials from moisture damage.
- 2. Request that the Owner designate an IAQ representative.
- 3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
- 4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
- 5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
- 6. Request copies of and follow all of the Owner's IAQ and infection control policies.
- 7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
- 8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
- 9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".
- 10. If permanently installed air handlers are used to serve both construction and occupied areas, all return grilles throughout construction areas shall be sealed to prevent air from construction areas being supplied to occupied areas.
- 11. If permanently installed air handlers are used during construction to serve only construction areas and do not supply air to adjacent occupied areas, MERV 8 filtration media shall be used to protect each return air grille or opening. The intent of this will be to prevent construction dust and debris from entering any return or supply air ductwork in the facility. All filtration media shall be replaced immediately prior to occupancy.
- 12. Construction areas shall be maintained at a negative pressure at all times during construction. When areas are under construction, HEPA filtered exhaust fan(s) shall be installed in sufficient quantities as required to maintain construction areas at sufficient negative pressure as called for in the Owner's Infection Control Risk Assessment (ICRA). HEPA filtered exhaust fan discharge shall be ducted either outdoors or back into designated hospital areas as called for in the Owner's ICRA.
- 13. For each area under construction, the Contractor shall install a negative pressure indicator equivalent to Lamiflow Model L-102F as manufactured by Lamiflow Technologies. Contractor shall regularly monitor and record the negative pressure condition of the construction areas as called for in the Owner's ICRA.

3.13 MAINTAINING CLEAN DUCTWORK THROUGHOUT CONSTRUCTION

- A. Throughout the duration of construction, all ductwork shall be capped or sealed with sheet metal caps, polyethylene film, or other airtight protective to keep dust, dirt, and construction debris out of ducts. Similar means shall be used to seal air-side connections of HVAC equipment to include, but not limited to, air handling units, fans, terminal air boxes, fan coil units, cabinet heaters, blower coils, and the like.

- B. When air terminal devices are installed, contractors shall seal all supply, return, and exhaust grilles with polyethylene film or other airtight protective to keep dust, dirt, and construction debris out of ducts.
- C. Should HVAC equipment be started during construction, Contractor shall remove airtight protectives and shall install one-inch thick MERV 8 filter media over all return and exhaust grilles to prevent dust, dirt, and construction debris from entering ductwork. Filter media shall cover the entire grille face and shall be secured such that air cannot bypass filter media.
- D. Should filter media become laden with dust and dirt, Contractor shall replace filter media with new media to prevent damage to air distribution system and equipment.
- E. The following steps shall be taken during testing, adjusting, and balancing of each air system:
 - 1. All construction activities in all spaces served by the air system shall stop.
 - 2. All airtight protectives and temporary filter media shall be removed from all portions of the air system.
 - 3. Testing, adjusting, and balancing work shall not commence until all construction activity is stopped and all airtight protectives and temporary filter media is removed.
 - 4. Once testing, adjusting, and balancing work is complete for the air system, airtight protectives or temporary filter media shall be installed over all ductwork openings and air terminals on the air system prior to resuming construction activities in any spaces served by the air system.
- F. The Owner shall agree the building is sufficiently clean prior to the removal of any filtration media and airtight protectives from air terminal devices.

3.14 UTILITY REBATE

- A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.
- B. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All air handling units operating and balanced.
3. All fans shall be operating and balanced.
4. All pumps, boilers and chillers operating and balanced.
5. All miscellaneous mechanical systems (unit heaters, fan coil units, cabinet heaters, etc.) operating.
6. All temperature control systems operating, programmed and calibrated.
7. Pipe insulation complete, pipes labeled and valves tagged.
8. Fire damper and fire/smoke damper access doors labeled in accordance with specifications.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 230505 - HVAC DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Mechanical demolition.
- B. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.
- B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.
- C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.
- D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.
- E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.
- F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.
- G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.2 PREPARATION

- A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal.

- B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.
- C. Existing Heating System: Maintain existing system in service until new system is complete and ready for service. Drain system only to make switchovers and connections. Obtain permission from the Owner at least 48 hours before partially or completely draining system. Minimize outage duration.
- D. Existing Medical Gas System: Maintain existing system in service until new system is complete and ready for service. Modify existing system only to make switchovers and connections. Obtain permission from the Owner at least 48 hours before system modification. Minimize outage duration. Certify system same day as new connections are made.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

- A. Demolish and extend existing mechanical work under provisions of Division 2 and this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned ducts and piping to source of supply and/or main lines.
- D. Remove exposed abandoned pipes and ducts, including abandoned pipes and ducts above accessible ceilings. Cut ducts flush with walls and floors, cap duct that remains, and patch surfaces. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.
- E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.
- H. Remove unused sections of supply and return air ductwork back to mains. Patch opening with sheet metal and seal airtight. Patch existing insulation to match existing. Where existing ductwork is to be capped and reused, locate the end cap within 6" of the last branch. End caps shall be 3" pressure class and seal class "A".
- I. Extend existing installations using materials and methods compatible with existing installations, or as specified.
- J. Properly reclaim and dispose of all refrigerant in demolished equipment and as required for extension of existing equipment.

3.4 CUTTING AND PATCHING

- A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 230529 for additional requirements.
- B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.
- C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.
- D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.
- E. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to discipline plans for additional information.
- F. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.5 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.
- C. MECHANICAL ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.6 SPECIAL REQUIREMENTS

- A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.
- B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.
- C. All medical gas piping scheduled for removal, relocation, extension, and/or revision will require re-certification by an independent agency acceptable to the Owner and NFPA-99 requirements. All testing shall conform to NFPA-99.

END OF SECTION

SECTION 230513 - MOTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Single Phase and Three Phase Electric Motors.

1.2 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- E. ANSI/NEMA MG 1 - Motors and Generators.
- F. ANSI/NFPA 70 - National Electrical Code.
- G. Energy Independence and Security Act of 2007.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 230500. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.
- B. Submit shop drawings for all three phase motors.
- C. Submit motor data with equipment when motor is installed by the manufacturer at the factory.
- D. Submit shaft grounding rings or brushes or ceramic bearings for all motors as required.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories, with a minimum of three years documented manufacturing experience.

PART 2 - PRODUCTS

2.1 MOTORS - GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

- B. Design motors for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- C. Explosion-Proof Motors: UL listed and labeled for the hazard classification shown on the drawing, with over-temperature protection.
- D. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.
- E. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- F. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.
- G. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.
- H. Each contractor shall set all motors furnished by him.
- I. All motors shall have a minimum service factor of 1.15.
- J. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.

- K. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.
- L. Aluminum end housings are not permitted on motors 15 HP or larger.
- M. Motor Driven Equipment:
 - 1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.
 - 2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.
- N. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Motors over 40 HP shall have dual screw adjusters. Slide bases shall conform to NEMA standards.
- O. Motors for fans and pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of varying motor speed.

2.2 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall integral surge protection. Motor shall be pre-wired for specific voltage and phase.
- B. Motor frame shall be NEMA 48; UL recognized components shall be provided for the motor construction.
- C. All EC motors shall be a minimum of 85% efficient at all speeds.
- D. Motors shall be permanently lubricated; utilize ball bearings to match with the connected driven equipment.
- E. Provide motor with on-board motor control module. Motor speed shall be limited to provide electronic over current protection. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed.
- F. Operational mode shall be as scheduled and shall be one of the following:
 - 1. Constant Flow
 - 2. Constant Temperature
 - 3. Constant Pressure

2.3 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

- A. All motors, unless exempted by EPCAct legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

HP	Full-Load Efficiencies % Open Drip-Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10.0	91.7	91.7	89.5	91.0	91.7	90.2
15.0	91.7	93.0	90.2	91.7	92.4	91.0
20.0	92.4	93.0	91.0	91.7	93.0	91.0
25.0	93.0	93.6	91.7	93.0	93.6	91.7
30.0	93.6	94.1	91.7	93.0	93.6	91.7
40.0	94.1	94.1	92.4	94.1	94.1	92.4
50.0	94.1	94.5	93.0	94.1	94.5	93.0
60.0	94.5	95.0	93.6	94.5	95.0	93.6
75.0	94.5	95.0	93.6	94.5	95.4	93.6
100.0	95.0	95.4	93.6	95.0	95.4	94.1
125.0	95.0	95.4	94.1	95.0	95.4	95.0
150.0	95.4	95.8	94.1	95.8	95.8	95.0
200.0	95.4	95.8	95.0	95.8	96.2	95.4
250.0	95.4	95.8	95.0	95.8	96.2	95.8
300.0	95.4	95.8	95.4	95.8	96.2	95.8
350.0	95.4	95.8	95.4	95.8	96.2	95.8
400.0	95.8	95.8	95.8	95.8	96.2	95.8
450.0	96.2	96.2	95.8	95.8	96.2	95.8
500.0	96.2	96.2	95.8	95.8	96.2	95.8

- B. Motor nameplate shall be noted with the above ratings.

2.4 MOTORS ON VARIABLE FREQUENCY DRIVES

- A. All motors driven by VFDs shall be premium efficiency type.
- B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.

- C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.
- D. All 480 volt motors driven by VFDs shall be provided with shaft grounding rings or grounding brushes or ceramic bearings as a means to protect bearings from adverse shaft currents.
 - 1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.
 - 2. Motor shafts 2" and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.
- B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.
- C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

END OF SECTION

SECTION 230529 - HVAC SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

1.2 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 230500. Include plastic pipe manufacturers' support spacing requirements.

1.3 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

- A. Refer to Section 230550 for additional requirements for seismic restraints.

2.2 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:
 - 1. Steel Pipe:
 - a. Hanger Rod Diameter:
 - 1) 2" and smaller: 3/8"
 - 2) 2-1/2" through 3-5/8": 1/2"
 - 3) 4" through 6": 1/2"
 - 4) 8": 5/8"
 - 5) 10": 3/4"
 - 6) 12": 7/8"
 - 7) 14" and 16": 1"
 - 8) 18" and 24": 1-1/4"

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.3 PIPE AND STRUCTURAL SUPPORTS

A. General:

- 1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
- 2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.

B. Vertical Supports:

- 1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.

a. Products:

- 1) Eaton Fig B3373 Series
- 2) nVent 510 Series
- 3) Anvil Fig. 90

- 2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.

a. Products:

- 1) Mason RBA, RCA or RDA
- 2) Mason BR

- 3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellant calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.

a. Products:

- 1) Pishields, Inc E1000, E1100, E1200, or E1300 (manufacturer to confirm based on pipe diameter and weight when in service)

4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.
5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp within their temperature limits of -65F to +225F.
3. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
4. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.

a. Products:

- 1) Anvil Fig. 160, 161, 162, 163, 164, 165
- 2) Eaton Fig. 3160, 3161, 3162, 3163, 3164, 3165
- 3) nVent Model 630, 631, 632, 633, 634, 635

5. Unless otherwise indicated, hangers shall be as follows:

a. Clevis Type: Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and Smaller:

1) Products: Bare Steel, Plastic or Insulated Pipe:

- a) Anvil Fig. 260
- b) Eaton Fig. 3100
- c) Roller Type: Service: Insulated Hot Pipe - 4 inches and Larger:

2) Products: 4" through 6":

- a) Anvil Fig. 181, 271
- b) Eaton Fig. 3110
- c) nVent Model 610

3) Products: 8" and Above:

- a) Anvil Fig. 171, 271
- b) Eaton Fig. 3114, 3117
- c) nVent Model 605

- b. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller:
 - 1) Products: Bare Steel Pipe:
 - a) Anvil Fig. 69
 - b) Eaton Fig. B3170NF
 - c) nVent Model 115
 - 2) Products: Bare Copper Pipe:
 - a) Eaton Fig. B3170CTC
 - b) nVent 102A0 Series
 - c) Anvil Fig. CT-69
- 6. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
 - a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
 - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
- 7. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
 - a. Clamp Type: Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller:
 - 1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp.
 - 2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
 - 3) Products: Bare Steel, Plastic or Insulated Pipe:
 - a) Unistrut Fig. P1100 or P2500
 - b) Eaton Fig. B2000 or B2400
 - c) Anvil Fig. AS1200
 - d) nVent USC
 - 4) Products: Bare Copper Pipe:
 - a) Eaton Fig. BVT
 - b) nVent CADDY Cushion Clamp

b. Roller Type: Service: Insulated Hot Pipe - 4 inches and larger:

- 1) Products: 4" through 6":
 - a) Unistrut Fig. P2474
 - b) Eaton Fig. B218
 - c) Anvil Fig. ROL-12
 - d) nVent ROL12
- 2) Products: 8" and Above:
 - a) Unistrut Fig. P2474-1
 - b) Eaton Fig. B219
 - c) nVent Fig. ROL-13
 - d) Anvil AS1902

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
 - a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):
 - 1) Products:
 - a) Anvil Fig. 86
 - b) Eaton Fig. B3033/B3034
 - c) nVent Model 300 & 310
 - b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):
 - 1) Products:
 - a) Anvil Fig. 228, 292
 - b) Eaton Fig. B3054
 - c) nVent Model 360
 - c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):
 - 1) Products:
 - a) MCL. M1, M2 or M3
 - d. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

e. Steel Structure Welding:

- 1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

2.4 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

C. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.5 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.
- F. Exposed Housing Penetrations: Seal pipes with surface temperature below 150F, penetrating housings with conical stepped, white silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite.

2.6 ROOF PENETRATIONS

- A. Roof Curb Enclosure: Provide weatherproof roof curb and enclosure for pipe and duct penetrations. Refer to drawings for details.
- B. Conical Pipe Boot: Seal pipes with surface temperature below 150F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: shall match roofing material.
- C. Break insulation only at the clamp for pipes between 60F and 150F. Seal outdoor insulation edges watertight.

2.7 SLEEVES AND LINTELS

- A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

- H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.
- J. Wall Seals ("Link-Seals"):
 - 1. Underground foundation wall penetrations and where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
 - 2. Sleeves, if used, shall be at least 2 pipe sizes larger than the service pipe and shall include a waterstop/anchor around the mid section of the sleeve, continuously welded to or integral formed with the sleeve. Sleeve material options based on fluid carrying pipe design temperature.
 - 3. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.
 - 4. Sealing element shall be as follows:

Mode 	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40F to 250F
T	High/Low Temperature (Steam)	Silicone	-67F to 400F
T	Fire Seals (1 hour)	Silicone	-67F to 400F
FS	Fire Seals (3 hours)	Silicone	-67F to 400F
OS	Oil Resistant/Stainless	Nitrile	-40F to 210F

- 5. Manufacturers:
 - a. Garlock Pipeline Technologies (GPT) "Link-Seals"
 - b. O-Z/Gedney Company
 - c. Calpico, Inc.
 - d. Innerlynx
 - e. Metraflex
 - f. Flexicraft
 - g. Polywater

2.8 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.9 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.10 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.11 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 HVAC SUPPORTS AND ANCHORS

- A. General Installation Requirements:
 - 1. Install all items per manufacturer's instructions.
 - 2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
 - 3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
 - 4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with Sheet Metal Contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.
- B. Supports Requirements:
 - 1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
 - 2. Set all concrete inserts in place before pouring concrete.
 - 3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.

4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. For attachments to joists that are concentrically loaded on the joist, a max of 100 lbs may be attached to the joist within a chord panel.
2. For attachments to joists that are eccentrically loaded, a max of 25 lbs may be attached to the joist within a chord panel without an additional angle.
3. Multiple attachments are allowed in each chord panel as long as the sum of the loads do not exceed the max load indicated.
4. For loads between 100 lbs - 200 lbs, additional L2x2x3/16" (L51xL51x4.8) ASTM A36 structural steel angles are required and joist must be concentrically loaded.
5. For loading conditions noted above, total sum of loads shall not exceed 200 lbs for an 8 ft segment for joist. For loads greater than 200 lbs and not noted on the drawings, contact engineer prior to installation.
6. No loads shall be supported from joist bridging.
7. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
8. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
 - 1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):
 - a. Maximum Spacing:
 - 1) 1-1/4" & under: 7'-0"
 - 2) 1-1/2": 9'-0"
 - 3) 2": 10'-0"
 - 4) 2-1/2": 11'-0"
 - 5) 3": 12'-0"
 - 6) 4" & larger: 12'-0"
 - 2. Steel (Std. Weight or Heavier - Vapor Service):
 - a. Maximum Spacing:
 - 1) 1-1/4" and under: 9'-0"
 - 2) 1-1/2": 12'-0"
 - 3) 2" & larger: 12'-0"
 - 3. Hard Drawn Copper & Brass (Liquid Service):
 - a. Maximum Spacing:
 - 1) 3/4" and under: 5'-0"
 - 2) 1": 6'-0"
 - 3) 1-1/4": 7'-0"
 - 4) 1-1/2" 8'-0"
 - 5) 2": 8'-0"
 - 6) 2-1/2": 9'-0"
 - 7) 3": 10'-0"
 - 8) 4": 12'-0"
 - 9) 6": 12'-0"
 - 4. Hard Drawn Copper & Brass (Vapor Service):
 - a. Maximum Spacing:
 - 1) 3/4" & under: 7'-0"
 - 2) 1": 8'-0"

- 3) 1-1/4": 9'-0"
- 4) 1-1/2": 10'-0"
- 5) 2": 11'-0"
- 6) 2-1/2" & larger: 12'-0"

I. Installation of hangers shall conform to MSS SP-58, 69, and 89.

END OF SECTION

SECTION 230550 - SEISMIC REQUIREMENTS FOR EQUIPMENT AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Seismic Requirements.

1.2 QUALITY ASSURANCE

A. General:

1. The contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint and support system and perform seismic calculations in accordance with these specifications, state, and local codes.
2. Items used for seismic restraint of equipment and systems shall be specifically manufactured for seismic restraint.
3. These requirements are beyond those listed in Section 230529 of these specifications. Where a conflict arises between the seismic requirements of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this Section.
2. Equipment: Each company providing equipment that must meet seismic requirements shall provide certification included in project submittals the equipment supplied for the project meets or exceeds the seismic requirements of the project.

- C. Testing Agency: An independent testing agency, acceptable to Authorities Having Jurisdiction, with experience and capability to conduct the testing indicated.

- D. Installer: Company specializing in performing the work of this Section.

1.3 REFERENCES

- A. Arkansas Building Code, 2021.
- B. ASHRAE - A Practical Guide to Seismic Restraint.
- C. Technical Manual 5-809-10, NAVFAC P-355, Air Force Manual 88-3, Chapter 13.
- D. ASCE 7-16, Chapter 13.
- E. SMACNA - Seismic Restraint Manual Guidelines for Mechanical Systems.
- F. NFPA 13 - Installation of Sprinkler Systems.

G. NFPA 14 - Standpipe and Hose Systems.

1.4 SUBMITTALS

A. Submit under provisions of Section 230500.

B. Shop Drawings:

1. Calculations, restraint selections, and installation details shall be designed and sealed by a Professional Engineer licensed in the state where the project is located experienced in seismic restraint design and installation.
2. Coordination Drawings: Plans and sections drawn to scale, coordinating seismic bracing of mechanical components with other systems and equipment in the vicinity, including other seismic restraints.
3. Manufacturer's Certifications: Professional Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
4. System Supports/Restraints - Submit for each condition requiring seismic bracing:
 - a. Calculations for each seismic brace and detail utilized on the project.
 - b. Plan drawings showing locations and types of seismic braces on contractor fabrication/installation drawings.
 - c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
 - d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.
5. Equipment - Submit for each piece of equipment supplied:
 - a. Certification that the equipment supplied for the project meets or exceeds the seismic requirements specified.
 - b. Specific details of seismic design features of equipment and maximum seismic loads imparted to the structural support.
 - c. Engineering calculations and details for equipment anchorage and support structure.

C. A seismic restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If seismic restraints are not provided for a system that requires seismic bracing, the seismic designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, utilized for each item. Seismic designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance to the exception.

1.5 TESTING AND INSPECTION

- A. Special Inspection and Testing shall be done in accordance with Chapter 17 of the Building Code.
- B. The Owner shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.
- C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.
- D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

1.7 DESIGN REQUIREMENTS

- A. This project is subject to the seismic bracing requirements of the International Arkansas Building Code, 2021 edition.
- B. The following criteria are applicable to this project:
 - 1. Risk Category: IV
 - 2. Seismic Importance Factor: $I_E = 1.5$ Seismic Design Category: D
 - 3. Component Amplification Factors (a_p) and Component Response Modification Factors (R_p) shall be taken from Table 13.5-1 in ASCE 7-16 for the individual equipment or system being restrained.
 - 4. Component Importance Factors (I_p) shall be taken from Section 13.1.3 in ASCE 7-16 for the individual equipment or system being restrained.
 - 5. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.
- C. Forces shall be calculated with the above requirements and Equation 13.3-1, -2, and -3 of ASCE 7-16, unless exempted by 13.1.4. Equipment shall meet Arkansas Building Code and ASCE 7 seismic qualification requirements in concurrence with ICC ES AC156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

- D. All seismic anchorage and bracing shall comply with the St. Louis County Rules & Regulations on Anchorage & Sway Bracing - Mechanical, Electrical & Plumbing (MEP) System Components.
- E. All seismic anchorage and bracing shall comply with FM Global Property Loss Prevention Data Sheet 1-11, Fire Following Earthquakes.

1.8 COORDINATION

- A. Coordinate layout and installation of seismic bracing with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.
- B. Coordinate concrete bases with building structural system.

1.9 WARRANTY

- A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SUPPLIERS

- A. Following is a partial list of manufacturer/supplier contact information for seismic restraints:
 - 1. B-Line Systems, Inc. (800) 851-7415, www.b-line.com.
 - 2. Unistrut Corporation <http://www.unistrut.us/>
 - 3. Kinetics Noise Control (877) 457-2695, www.kineticsnoise.com.
 - 4. Mason Industries, Inc. www.mason-ind.com.
 - 5. Loos & Co., Inc. (800) 321-5667, www.loosnaples.com.
 - 6. Tolco (909) 737-5599, www.tolco.com
 - 7. ISAT 877.523.6060, www.isatsb.com
 - 8. Vibro-Acoustics (416) 291-7371 , <https://virs.vibro-acoustics.com/>

2.2 SEISMIC DESIGN CRITERIA

- A. This section describes the requirements for seismic restraint of systems and equipment related to continued operation of the facility after a design seismic event.
- B. Definitions
 - 1. Stay in Place:
 - a. All systems and equipment shall be anchored and restrained such that the anchoring system is intended not to fail and equipment and/or system components will not fall.

2. Remain Operational:

- a. Requirements for "Stay in Place" listed above shall be met.
- b. The following systems and associated equipment are intended not to fail externally or internally and are intended to continue operation following a seismic event:
 - 1) Heating
 - 2) Cooling
 - 3) Humidification
 - 4) Air Handling
 - 5) Exhaust

2.3 SEISMIC BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

- 1. Seismic restraint designer shall coordinate all attachments with the Structural Engineer of Record; refer to submittal requirements.
- 2. The seismic restraint design shall be based on actual equipment data obtained from manufacturer's submittals or the manufacturer. The equipment manufacturer shall verify and provide written certification the attachment points on the equipment can accept the combination of seismic, weight, and other imposed loads.
- 3. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
- 4. Analysis shall detail anchoring methods, bolt diameter, embedment, and weld length.
- 5. All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code.
- 6. All seismic restraints and combination isolator/restraints shall have verification of their seismic capabilities witnessed by an independent testing agency.

B. Friction from gravity loads shall not be considered resistance to seismic forces.

C. Fire protection systems shall meet the requirements of NFPA-13 and NFPA-14 for the building seismic requirements.

D. Housekeeping Pads:

- 1. Reinforced housekeeping pads shall be provided to handle shear, tension, and compression forces with proper reinforcement, doweling, and attachments connecting the pad to the structural slab.
- 2. New Bases for Existing Buildings: In addition to forces noted above, proper bonding of new equipment bases to existing concrete floors shall include: Existing concrete shall be thoroughly cleaned, scarified, and a bonding agent applied, in accordance with manufacturer's instructions, prior to placing new concrete. Bonding agent shall be "Weld-Crete" as manufactured by the Larsen Products Corporation or "Nitobond Acrylic" as manufactured by Fosroc Inc. or approved equivalent.

2.4 SEISMIC RESTRAINT AND CONSTRUCTION OF EQUIPMENT

- A. Equipment supplied for the project shall be designed to meet the requirements of lateral forces calculated using the applicable code and method described above.
- B. The following is a partial list of equipment that shall be restrained and that shall be constructed to meet seismic forces described in this section:
 - 1. Pumps
 - 2. Tanks
 - 3. Air Handling Units
 - 4. Chillers
 - 5. Boilers

2.5 MATERIALS

- A. Use the following materials for restraints:
 - 1. Indoor Dry Locations: Steel, zinc plated.
 - 2. Outdoors and Damp Locations: Galvanized steel.
 - 3. Corrosive Locations: Stainless steel.

2.6 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

- A. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
- B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with IBC, ACI and ICC ES requirements for cracked concrete anchors.
- C. Concrete Inserts: Steel-channel type.
- D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125, Grade A 325.
- E. Welding Lugs: Comply with MSS SP-69, Type 57.
- F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.
- G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.7 SEISMIC BRACING COMPONENTS

- A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch-thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.
 - 1. Materials for Channel: ASTM A 1011, GR 33.
 - 2. Materials for Fittings and Accessories: ASTM A 635, ASTM A 576, or ASTM A 36.
 - 3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
 - 4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.
- B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.
- C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.
 - 1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
 - 2. Wire Rope Cable: Comply with ASTM A 603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.
- D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to the applicable code sections and Authority Having Jurisdiction for the exact seismic restraint requirements of piping, ductwork, conduit, equipment, etc.
- B. Layout of transverse and longitudinal bracing shall follow recommendations of approved design standards listed in Part 1 of this specification section.
- C. All rigid floor mounted equipment shall have a resilient media between the equipment mounting hole and the anchor bolt in concrete.
- D. All seismic restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
- E. Installation of seismic restraints shall not cause any change in position of equipment, piping, or ductwork, resulting in stresses or misalignment.
- F. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

- G. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified.
- H. Coordinate work with all other trades to avoid rigid contact with the building. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Architect/Engineer's attention prior to specific equipment selection.
- I. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
- J. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or International Code Council approved seismic anchors for installation in concrete.
- K. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit.
- L. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.
- M. Do not install cables over sharp corners.
- N. Brace support rods when necessary to accept compressive loads. Welding of compression braces to the vertical support rods is not acceptable.
- O. Provide reinforced clevis bolts when required.
- P. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.
- Q. Post-Installed anchors shall be provided to meet seismic requirements.
- R. Vertical pipe risers flexibly supported to accommodate thermal motion and/or pipe vibration shall be guided to maintain pipe stability and provide horizontal seismic restraint.
- S. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.
- T. Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent piping.
- U. Water tanks shall be secured to their saddles by welding or proper concrete attachment, and those saddles shall be properly attached to the structure.

- V. Brace all terminal units with water coils as required by the building code and provide flexible connection to the coil if bracing is required.
- W. Independently brace duct mounted equipment (terminal units, in-line fans, etc.) and the associated suspended ductwork.
- X. Do not brace a system to two different structures such as a wall and a ceiling.
- Y. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.
- Z. Positively attach all roof mounted equipment to roof curbs. Positively attach all roof curbs to building structure.
- AA. Exposed seismic supports in occupied areas shall be guarded or covered to protect occupants.
- BB. Coordinate seismic bracing of architecturally exposed ductwork with the Architect/Engineer.

3.2 SEISMIC RESTRAINT EXCLUSIONS

- A. Refer to the applicable code sections and Authority Having Jurisdiction for allowable exclusions.

END OF SECTION

SECTION 230553 - HVAC IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Identification of products installed under Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. 3M
- B. Bunting
- C. Calpico
- D. Craftmark
- E. Emedco
- F. Kolbi Industries
- G. Seton
- H. W.H. Brady
- I. Marking Services.

2.2 MATERIALS

- A. General:
 - 1. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
 - 2. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
 - 3. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
 - 4. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- B. Pipe Markers:
 - 1. All pipe markers shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker	Size of Letters

	Length	
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"
Plastic tags may be used for outside diameters under 3/4"		

2. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
3. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.
4. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.

C. Ductwork Markers:

1. Ductwork systems shall be provided with preprinted, color-coded lettering indicating service, equipment serving, and arrow showing flow direction. Refer to Part 3 for installation information.
2. Self-Adhesive Vinyl Duct Labels: Colored vinyl with permanent Contact-type permanent pressure-sensitive adhesive backing suitable for indoor and outdoor application compatible with label and with substrate. Stencil painted markers are not permitted on ductwork systems.
3. Maximum Temperature: Able to withstand temperatures up to 160F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch by 3/4 inch.
5. 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 1-1/2 inches high beyond 72 inches viewing distance. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
7. Ductwork systems containing hazardous materials shall be provided with minimum 2" x 4" ANSI Z535.2 biohazard warning labels with custom labeling describing hazard. Refer to Part 3 for system and label description.

D. Hazardous System Maintenance Access Doors:

1. Doors and roof hatches used to access equipment serving hazardous ductwork systems shall be provided with a minimum 4" x 6" ANSI Z535.2 biohazard warning label. Label shall read "WARNING - BIOHAZARD. ONLY AUTHORIZED PERSONNEL BEYOND THIS POINT".
2. Coordinate location of warning label with Owner.

E. Ceiling Markers:

1. Label Style:

- a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves. An arrow can be used to point to the tile needing removal.
- b. The label tape shall be approximately 1/2" wide with all capitalized letters approximately 3/16" tall.
- c. Ceiling grid labels shall be made with a label maker with durable adhesive labels having a clear background and black letters.
- d. Equipment labels shall be as designated on the drawings (e.g., FCU-606B, etc.).
- e. Valve labels shall be designated by the size, service, and the valve tag number (e.g., 1-1/4" CW #123, 2" HWS #234, etc.). A single longer label can be used to identify multiple valves using spaces between the descriptors if the valves are located close together and have the same service (e.g., HWS and HWR valves serving the same equipment or CW, HW, and HWC lines serving the same restroom, etc.).
- f. Fire, fire/smoke and smoke dampers shall be labeled consistent with the type (e.g., Fire Damper, Fire/Smoke Damper, etc.).

2. "Dot" Style:

- a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves.
- b. The marker shall be a self-adhesive color dot approximately 1/2" in diameter.
- c. The equipment and accessories to be marked and dot color shall be coordinated with the Architect/Engineer and Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
 1. All valves (except shutoff valves at equipment) shall have numbered tags.
 2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.

3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
5. Attach to handwheel or around valve stem.
6. Number all tags and show the service of the pipe.
7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
8. Provide one 36" x 24" minimum Plexiglas framed piping schematic showing valve locations with respective tag numbers. Mount directory in location chosen by the Architect/Engineer.
9. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
3. Stencil Painted Pipe Markers:
 - a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
 - b. Apply primer on non-insulated pipes before painting.
 - c. Use background and letter colors as scheduled later in this section.
4. Apply markers and arrows in the following locations where clearly visible:
 - a. At each valve.
 - b. On both sides of walls that pipes penetrate.
 - c. At least every 20 feet along all pipes.
 - d. On each riser and each leg of each "T" joint.
 - e. At least once in every room and each story traversed.
5. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

E. Ductwork Markers:

1. Apply ductwork markers on ductwork systems containing hazardous materials in the following locations where clearly visible:
 - a. On both sides of walls that ducts penetrate.
 - b. At least every 20 feet along all ducts.

- c. On each riser and each leg of each branch connection.
- d. At least once in every room and each story traversed.
- e. At all ductwork access doors.
- f. At all fans and equipment serving ductwork system. Markers shall be clearly visible from the normal maintenance access path to the equipment. Coordinate placement location with Owner.

F. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

G. Miscellaneous:

1. Attach self-adhesive vinyl labels at all duct access doors used to reset fusible links or actuators on fire, fire/smoke, or smoke dampers. Lettering shall be a minimum of 1/2" high. Labels shall indicate damper type.
2. Provide engraved plastic tags at all hydronic or steam system make-up water meters.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. STEAM - 5 PSI: Black lettering; yellow background
2. HEATING WATER SUPPLY: White lettering; green background
3. HEATING WATER RETURN: White lettering; green background
4. CHILLED WATER SUPPLY: White lettering; green background
5. CHILLED WATER RETURN: White lettering; green background
6. CONDENSATE DRAIN: White lettering; green background
7. MEDICAL VACUUM - 15-30 IN. HG: Black lettering; white background
8. WASTE ANESTHETIC GAS DISPOSAL - 15-30 IN. HG: White lettering; violet background
9. CARBON DIOXIDE - 50-55 PSI: White lettering; gray background
10. INSTRUMENT AIR - 160-185 PSI: White lettering; black background
11. MEDICAL AIR - 50-55 PSI: Black lettering; yellow background
12. NITROGEN - 160-185 PSI : White lettering; black background
13. NITROUS OXIDE - 50-55 PSI: White lettering; blue background
14. OXYGEN - 50-55 PSI: White lettering; green background

B. Steam pipe markers shall include operating steam pressure within pipes shown above.

- C. Medical gas pipe markers shall include system operating pressure shown above.
- D. Medical gas pipe markers for systems not listed shall meet the pipe labeling requirements of NFPA-99.
- E. Ductwork and Fan Systems: All fans, filters housings, and access doors shall be labeled with text as follows:
 - 1. WARNING - CHEMICAL FUME EXHAUST: Black lettering; orange/white background
 - 2. SUPPLY AIR: White lettering; green background
 - 3. RETURN AIR: White lettering; green background
 - 4. GENERAL EXHAUST AIR: Black lettering; yellow background
 - 5. VENTILATION AIR: White lettering; green background
 - 6. RELIEF Black lettering; yellow background
- F. Ceiling Markers:
 - 1. TAB-##
 - 2. FCU-##
 - 3. FSD
 - 4. FD
 - 5. SD
 - 6. KITCHEN EXHAUST ACCESS
 - 7. SMOKE DETECTOR
 - 8. MOTOR OPERATED DAMPERS
 - 9. CONTROL VALVES
 - 10. CLEAN OUT Condensate
 - 11. BRANCH SELECTOR (VRF System)

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjusting, and balancing of air systems.
- B. Testing, adjusting, and balancing of heating systems.
- C. Testing, adjusting, and balancing of cooling systems.
- D. Testing, adjusting, and balancing of plumbing systems.

1.2 QUALITY ASSURANCE

- A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years' experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, or TABB Certified Supervisor.
- B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

1.3 REFERENCES

- A. AABC - National Standards for Total System Balance, Seventh Edition.
- B. ADC - Test Code for Grilles, Registers, and Diffusers.
- C. AMCA - Publication 203-90; Field Performance Measurement of Fan Systems.
- D. ASHRAE - 2019 HVAC Applications Handbook; Chapter 39, Testing, Adjusting and Balancing.
- E. ASHRAE/ANSI - Standard 111-2008; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.
- F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Ninth Edition, 2019.
- G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing (latest edition).
- H. TABB - International Standards for Environmental Systems Balance.

1.4 SUBMITTALS

- A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.

B. Electronic Copies:

1. Submit a certified copy of test reports to the Architect/Engineer for approval. Electronic copies shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Copies that are not legible will be returned to the Contractor for resubmittal. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
2. Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
3. All text shall be searchable.
4. Bookmarks shall be used. All bookmark titles shall be an active link to the index page and index tabs.

1.5 REPORT FORMS

- A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.
- B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.
- C. Refer to PART 4 for required reports.

1.6 WARRANTY/GUARANTEE

- A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 manhours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.7 SCHEDULING

- A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the Architect/Engineer prior to performing each test.
- B. Project will be constructed in phases. Provide balancing report after each phase is complete.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.
- B. The Balancing Contractor shall incorporate all pertinent documented construction changes (e.g. submittals/shop drawings, change orders, RFIs, ASIs, etc.) and include in the balancing report.
- C. Recorded data shall represent actual measured or observed conditions.
- D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.
- E. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.
- G. The Balancing Contractor shall measure terminal air box air flow, and the TCC shall adjust DDC readout to match. Refer to Section 230900 for additional information.
- H. Installations with systems consisting of multiple components shall be balanced with all system components operating.

3.2 EXAMINATION

- A. Before beginning work, verify that systems are complete and operable. Ensure the following:
 - 1. General Equipment Requirements:
 - a. Equipment is safe to operate and in normal condition.
 - b. Equipment with moving parts is properly lubricated.
 - c. Temperature control systems are complete and operable.
 - d. Proper thermal overload protection is in place for electrical equipment.
 - e. Direction of rotation of all fans and pumps is correct.
 - f. Access doors are closed and end caps are in place.

2. Duct System Requirements:

- a. All filters are clean and in place. If required, install temporary media.
- b. Duct systems are clean and free of debris.
- c. Fire/smoke and manual volume dampers are in place, functional and open.
- d. Air outlets are installed and connected.
- e. Duct system leakage has been minimized.

3. Pipe System Requirements:

- a. Coil fins have been cleaned and combed.
- b. Hydronic systems have been cleaned, filled, and vented.
- c. Strainer screens are clean and in place.
- d. Shutoff, throttling and balancing valves are open.

- B. Report any defects or deficiencies to Architect/Engineer.
- C. Promptly report items that are abnormal or prevent proper balancing.
- D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- E. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Architect/Engineer for spot checks during testing.
- B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

3.4 INSTALLATION TOLERANCES

- A. $\pm 10\%$ of scheduled values:
 - 1. Adjust air inlets and outlets to $\pm 10\%$ of scheduled values.
 - 2. Adjust piping systems to $\pm 10\%$ of design values.
- B. $\pm 5\%$ of scheduled values:
 - 1. Adjust fume exhaust systems to $\pm 5\%$ of scheduled values.
 - 2. Adjust supply and exhaust air-handling systems for space pressurization to $\pm 5\%$ of scheduled values, and to provide proper pressurization.
- C. $\pm 5\%$ of scheduled values
 - 1. Adjust outdoor air intakes to within $+ 5\%$ of scheduled values.
 - 2. Adjust exhaust air through energy recovery equipment to within $+ 5\%$ of scheduled values.

- D. Adjust supply, return, and exhaust air-handling systems to +10% / -5% of scheduled values.

3.5 ADJUSTING

- A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.
- B. Once balancing of systems is complete, at least one damper or valve must be 100% open.
- C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.
- D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.
- E. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on all pumps not driven by a VFD. Coordinate with contractor.

3.6 SUBMISSION OF REPORTS

- A. Fill in test results on appropriate forms.

PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

4.1 VERIFICATION OF EXISTING SYSTEMS.

- A. Perform a pre-balance of systems serving the area of construction prior to the start of any other work. Do not make adjustments to the systems. If the systems are not operating at maximum capacity, temporarily drive system to maximum and take readings for the system. Return the system to its original state when measurements are complete.
 - 1. Air Handling Unit: Refer to pre design TAB report for existing operating conditions.
 - 2. Exhaust Fan
 - a. Drawing symbol.
 - b. Location.
 - c. Manufacturer and model.
 - d. Flow rate (cfm).
 - e. Total static pressure. (Indicate measurement locations).
 - f. Inlet pressure.
 - g. Discharge pressure.
 - h. Fan RPM.
 - 3. Air Terminal (Inlet or Outlet):
 - a. Room number/location.

- b. Terminal type and size.
- c. Velocity.
- d. Flow rate (cfm)
- e. Percent of design flow rate.

4. Air Terminal Unit (Terminal Air Box) Data:

a. General Requirements:

- 1) Drawing symbol.
- 2) Location.
- 3) Manufacturer and model.
- 4) Size.
- 5) Type: constant, variable, single, dual duct.

b. Flow Rate:

- 1) Cooling maximum flow rate (cfm).
- 2) Heating maximum flow rate (cfm).
- 3) Minimum flow rate (cfm).
- 4) Water flow rate (gpm).

c. Temperature:

- 1) Entering air temperature.
- 2) Leaving air temperature (in heating mode).
- 3) Entering water temperature.
- 4) Leaving water temperature.

d. Pressure Drop and Pressure:

- 1) Inlet static pressure during testing.
- 2) Coil air pressure drop.
- 3) Water pressure drop.

B. Report findings to Architect/Engineer on standard forms.

4.2 GENERAL REQUIREMENTS

A. Title Page:

- 1. Project name.
- 2. Project location.
- 3. Project Architect.
- 4. Project Engineer (IMEG Corp.).
- 5. Project General Contractor.
- 6. TAB Company name, address, phone number.
- 7. TAB Supervisor's name and certification number.
- 8. TAB Supervisor's signature and date.
- 9. Report date.

B. Report Index

C. General Information:

1. Test conditions.
2. Nomenclature used throughout report.
3. Notable system characteristics/discrepancies from design.
4. Test standards followed.
5. Any deficiencies noted.
6. Quality assurance statement.

D. Instrument List:

1. Instrument.
2. Manufacturer, model, and serial number.
3. Range.
4. Calibration date.

4.3 AIR SYSTEMS

A. Duct Leakage Test:

1. Air system and fan.
2. Leakage class.
3. Test pressure.
4. Construction pressure.
5. Flow rate (cfm): specified and actual.
6. Leakage (refer to Section 233100 in the specifications): specified and actual.
7. Statement that fire dampers, reheat coils and other accessories were included in the test.
8. Pass or Fail.
9. Test performed by.
10. Test witnessed by.

B. Air Moving Equipment:

1. General Requirements:

- a. Drawing symbol.
- b. Location.
- c. Manufacturer, model, arrangement, class, discharge.
- d. Fan RPM.
- e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
- f. Final frequency of motor at maximum flow rate (on fans driven by VFD).

2. Flow Rate:

- a. Supply flow rate (cfm): specified and actual.
- b. Return flow rate (cfm): specified and actual.
- c. Outside flow rate (cfm): specified and actual.

- d. Exhaust flow rate (cfm): specified and actual.
- 3. Pressure Drop and Pressure:
 - a. Filter pressure drop: specified and actual.
 - b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
 - c. Inlet pressure.
 - d. Discharge pressure.
- C. Fan Data:
 - 1. Drawing symbol.
 - 2. Location.
 - 3. Manufacturer and model.
 - 4. Flow rate (cfm): specified and actual.
 - 5. Total static pressure: specified and actual. (Indicate measurement locations).
 - 6. Inlet pressure.
 - 7. Discharge pressure.
 - 8. Fan RPM.
- D. Electric Motors:
 - 1. Drawing symbol of equipment served.
 - 2. Manufacturer, Model, Frame.
 - 3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
 - 4. Measured: Amps in each phase.
- E. Duct Traverse:
 - 1. System zone/branch/location.
 - 2. Duct size.
 - 3. Free area.
 - 4. Velocity: specified and actual.
 - 5. Flow rate (cfm): specified and actual.
 - 6. Duct static pressure.
 - 7. Air temperature.
 - 8. Air correction factor.
- F. Air Terminal (Inlet or Outlet):
 - 1. Drawing symbol.
 - 2. Room number/location.
 - 3. Terminal type and size.
 - 4. Velocity: specified and actual.
 - 5. Flow rate (cfm): specified and actual.
 - 6. Percent of design flow rate.

G. Air Terminal Unit (Terminal Air Box) Data:

1. General Requirements:

- a. Drawing symbol.
- b. Location.
- c. Manufacturer and model.
- d. Size.
- e. Type: constant, variable, single, dual duct.

2. Flow Rate:

- a. Cooling maximum flow rate (cfm): specified and actual.
- b. Heating maximum flow rate (cfm): specified and actual.
- c. Minimum flow rate (cfm): specified and actual.
- d. Water flow rate (gpm): specified and actual with system performance adjusted as follows:
 - 1) Adjust heating water system pump to maintain maximum system differential pressure.
 - 2) Set calibrated balance valve fully open.
 - 3) Command terminal air box control valve to fully open.
 - 4) Measure heating coil flow using calibrated balance valve.
 - 5) Note: Commanding terminal air box control valve to be fully open shall be done on a valve-by-valve basis. Do not command all control valves to be fully open at the same time, as the heating water system may not have sufficient capacity.
 - 6) Note: After Balancing of all terminal air boxes is complete, release the heating water pump to automatically reset the system DP based on control valve position per sequence of operation requirements.

3. Temperature:

- a. Entering air temperature: specified and actual.
- b. Leaving air temperature (in minimum airflow/heating mode): specified and actual.
- c. Entering water temperature: specified and actual.
- d. Leaving water temperature: specified and actual.

4. Pressure Drop and Pressure:

- a. Inlet static pressure during testing cooling maximum airflow rate (maximum and minimum).
- b. Water pressure drop: specified and actual.

H. Air Flow Measuring Station:

1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.

5. Size.
6. Flow rate (cfm): specified and actual.
7. Pressure drop: specified and actual.

I. Fume Hood:

1. Drawing symbol.
2. Location.
3. Manufacturer and Model.
4. Total flow rate (cfm): specified and actual.
5. Test velocities.
6. Hood opening dimensions.

J. Positive Air Flow Test:

1. Occupied Supply Air (Max./Min.) Flow rate (cfm): specified and actual.
2. Occupied Return Air (Max./Min.) Flow rate (cfm): specified and actual.
3. Unoccupied Supply Air (Max./Min.) Flow rate (cfm): specified and actual.
4. Unoccupied Return Air (Min./Max.) Flow rate (cfm): specified and actual.

4.4 HEATING SYSTEMS

A. Pump Data (Primary and Secondary Heating Water Loop Pumps):

1. Existing drawing symbol or equipment TAG
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: Operating and shutoff.
8. Discharge Pressure: Operating and shutoff.
9. Final frequency of motor at maximum flow rate (on pumps driven by VFD).

B. Electric Motors (Associated Heating Water Loop Pump Motors):

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps in each phase.

C. Heating Coils:

1. General Requirements:
 - a. Drawing symbol.
 - b. Service.
 - c. Location.
 - d. Manufacturer and model.
 - e. Size.

2. Flow Rate:
 - a. Flow rate (cfm): specified and actual.
 - b. Water flow rate: specified and actual.
 3. Temperature:
 - a. Entering air temperature: specified and actual.
 - b. Leaving air temperature: specified and actual.
 - c. Entering water temperature: specified and actual.
 - d. Leaving water temperature: specified and actual.
 4. Pressure Drop and Pressure:
 - a. Air pressure drop: specified and actual.
 - b. Steam pressure after valve: specified and actual.
 - c. Water pressure drop: specified and actual.
 5. Energy:
 - a. Air Btuh ($\text{cfm} \times \text{temp rise} \times 1.09$).
 - b. Water Btuh ($\text{gpm} \times \text{temp drop} \times 500$). Repeat tests if not within 10% of air Btuh.
- D. Terminal Heat Transfer Units:
1. General Requirement:
 - a. Drawing symbol.
 - b. Location.
 - c. Manufacturer and model.
 - d. Include air data only for forced air units.
 2. Flow Rate:
 - a. Flow rate (cfm): specified and actual.
 - b. Water flow rate (cfm): specified and actual.
 3. Temperature:
 - a. Entering air temperature: specified and actual.
 - b. Leaving air temperature: specified and actual.
 - c. Entering water temperature: specified and actual.
 - d. Leaving water temperature: specified and actual.
 4. Energy:
 - a. Air Btuh ($\text{cfm} \times \text{temperature rise} \times 1.09$).
 - b. Water Btuh ($\text{gpm} \times \text{temperature drop} \times 500$). Repeat tests if not within 10% of air Btuh.

4.5 COOLING SYSTEMS

A. Cooling Coils:

1. General Requirements:

- a. Drawing symbol.
- b. Service.
- c. Location.
- d. Size.
- e. Manufacturer and model.

2. Temperature:

- a. Entering air DB temperature: specified and actual.
- b. Entering air WB temperature: specified and actual.
- c. Leaving air DB temperature: specified and actual.
- d. Leaving air WB temperature: specified and actual.
- e. Entering water temperature: specified and actual.
- f. Leaving water temperature: specified and actual.

3. Flow Rate:

- a. Flow rate (cfm): specified and actual.
- b. Water flow rate (gpm): specified and actual.

4. Pressure Drop and Pressure:

- a. Water pressure drop: specified and actual.
- b. Air pressure drop: specified and actual.

5. Energy:

- a. Air Btuh (cfm x enthalpy change x 4.5).
- b. Water Btuh (gpm x temperature drop x 500). Repeat tests if not within 10% of air Btuh.

B. Terminal Heat Transfer Units:

1. General Requirements:

- a. Drawing symbol.
- b. Location.
- c. Manufacturer and model.
- d. Include air data only for forced air units.

2. Temperature:

- a. Entering air DB temperature: specified and actual.
- b. Leaving air DB temperature: specified and actual.
- c. Entering water temperature: specified and actual.
- d. Leaving water temperature: specified and actual.

3. Flow rate:
 - a. Flow rate (cfm): specified and actual.
 - b. Water flow (gpm): specified and actual.
4. Energy:
 - a. Air Btuh (cfm x temperature rise x 1.09).
 - b. Water Btuh (gpm x temperature drop x 500). Repeat tests if not within 10% of air Btuh.

4.6 PLUMBING SYSTEMS

A. Pump Data:

1. Drawing symbol.
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: operating and shutoff.
8. Discharge Pressure: operating and shutoff.

B. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, model, frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

C. Balancing Valve:

1. Drawing symbol.
2. Service.
3. Location.
4. Size.
5. Manufacturer and model.
6. Flow rate (gpm): specified and actual.
7. Pressure drop: specified and actual.

END OF SECTION

SECTION 230713 - DUCTWORK INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Ductwork Insulation.
- B. Insulation Jackets.

1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in ductwork insulation application with five years minimum experience. When requested, installer shall submit manufacturer's certificate indicating qualifications.
- B. Materials:
 - 1. Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
 - 2. Fungal Resistance: No growth when tested in accordance with ASTM G21 (antifungal test).
 - 3. Rated velocity on coated air side for air erosion in accordance with UL 181 at 5,000 fpm minimum.
 - 4. UL listed in Category HNKT.
- C. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 230500. Include product description, list of materials and thickness for each service, and location.
- B. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 / 0.26 (Out-Of-Package/Installed-Compressed 25%) maximum 'K' value at 75F; foil scrim Kraft facing, 1.0 lb./cu. ft. density. Submit both "Out of Package" and "Installed-Compressed 25%" K and R-values.
- B. Type B: Semi-rigid Fiberglass Board Wrap - Outside Application; ANSI/ASTM C612, Class 1; 0.25 maximum 'K' value at 75F; foil scrim Kraft facing, 3 lb./cu. ft. density.

R-VALUE PER THICKNESS

TYPE	THICKNESS	0.5	1	1.5	2	2.5	3	4	5
	K-FACTOR	R-VALUE							
Flexible Fiberglass Outside Wrap	0.28			5.4	7.1	8.9	10.7	14.3	17.9
Semi-Rigid Fiberglass Board Wrap	0.25			6.0	8.0	10.0	12.0	16.0	20.0
Flexible Fiberglass Liner	0.28	1.8	3.6	5.4	7.1	8.9	10.7	14.3	17.9
Rigid fiberglass liner Double Wall	0.23		4.3	6.5	8.7	10.9	13.0	17.4	21.7
Ductwork	0.27		3.7	5.6	7.4	9.3	11.1	14.8	18.5
Flexible High Temp Rigid Preformed Fiberglass Acoustical Liner	0.23		4.3	6.5	8.7	10.9	13.0	17.4	21.7

2.2 JACKETS

- A. Vapor Barrier Jackets: Kraft reinforced foil scrim vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 25 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.
- B. Install materials after ductwork has been tested.
- C. Clean surfaces for adhesives.
- D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.
- E. Exterior Duct Wrap - Flexible, Type A:
 - 1. Apply with edges tightly butted.
 - 2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.
 - 3. Seal joints with adhesive backed tape.
 - 4. Apply so insulation conforms uniformly and firmly to duct.
 - 5. Seal all penetrations of the vapor barrier by strap hangers or slip cable hangers with adhesive backed tape.

6. Provide high-density insulation inserts on rectangular ducts at trapeze duct hangers to prevent crushing of insulation. Provide high-density insulation inserts with clamp-on round ducts requiring two (2) rods or straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
7. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Architect/Engineer.
8. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.
9. Staples may be used, but must be covered with tape.
10. Vapor barrier must be continuous.
11. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.

F. Semi Rigid Fiberglass Board Wrap - Type B (Indoor Use):

1. Impale on pins welded to the duct and secured with speed clips. Clip pins off close to speed clips.
2. Space pins as needed to hold insulation firmly against duct, but not less than one pin per square foot. Pins must be long enough to avoid compressing the insulation.
3. Seal all joints and speed clips with glass fabric set in adhesive or a 3" wide strip of Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK facing tape.
4. For small areas, secure insulation with adhesive over the entire surface of the duct. Use adhesive in addition to pins as needed to prevent sagging on horizontal surfaces.

G. Continue insulation with vapor barrier through penetrations unless code prohibits.

H. Provide 2" wide, 24" high, 26 gauge, galvanized sheet metal corner protection angles for all externally insulated ductwork extending to a floor or curb.

3.2 SCHEDULE

A. Refer to Ductwork Application Schedule on Drawings for scheduling of insulation.

END OF SECTION

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping Insulation.
- B. Insulation Jackets.

1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with five years minimum experience.
- B. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 230500. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
- B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534, Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75F, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.

2.2 VAPOR BARRIER JACKETS

- A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.
- B. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

2.3 JACKET COVERINGS

- A. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40F to 150F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.
- B. Patch and repair torn insulation. Paint to match adjacent insulation surface.

3.2 INSTALLATION

- A. General Installation Requirements:
 - 1. Install materials per manufacturer's instructions, building codes and industry standards.
 - 2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
 - 3. All piping and insulation that does not meet 25/50 that is in an air plenum shall have written approval from the Authority Having Jurisdiction and the local fire department for authorization and materials approval. If approval has been allowed, the non-rated material shall be wrapped with a product that has been listed and labeled having a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested as a composite in accordance with ASTM E84 or UL 723.
 - 4. On 1" and smaller piping routed through metal wall studs, provide a plastic grommet to protect the piping. The piping shall be insulated between the wall studs, and the insulation shall butt up to each stud.
- B. Insulated Piping Operating Below 60F:
 - 1. Insulate fittings, valves, unions, flanges, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.

2. On piping operating below 60F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
 3. All balance valves and strainers with fluid operating below 60F shall be insulated with a removable plug wrapped with vapor barrier tape to allow access for reading and adjusting of the balancing valve and cleaning and servicing of the balancing valve.
- C. Insulated Piping Operating Between 60F and 140F:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.
- D. Insulated Piping Operating Above 140F:
1. Insulate fittings, valves, flanges, float & thermostatic steam traps, and strainers. On gate valves, the insulation shall be extended to cover the entire valve bonnet, leaving only the portion of the stem that is above the bonnet and valve operator exposed.
 2. All balance valves with fluid operating above 140F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.
 3. The use of removable insulation jackets is acceptable for insulating large and non-cylindrical shaped piping components (e.g., check valves, pressure regulating valves, calibrated balance valves, gate valve bonnets, F&T traps, strainers, line sets, and the like).
- E. Refrigerant Piping:
1. On refrigerant piping (25F and above) and not required to meet the 25/50 flame/smoke, provide at each strut or clevis support an insulation coupling to support pipe and to accept insulation thickness of adjoining insulation, to prevent insulation from sagging and crushing. The coupling shall be suitable for planned temperatures, use with specified pipe material, and shall be a 360-degree, one-piece cylindrical segment. Use mechanical fasteners where coupling cannot be installed on pipe during installation. Contractor shall apply adhesive to ends of insulation entering insulation coupling to maintain vapor barrier.
- F. Exposed Piping:
1. Locate and cover seams in least visible locations.
 2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.
- 3.3 SUPPORT PROTECTION
- A. Insulation with pipe size greater than 1-1/2" (38mm) shall be protected from sagging and crushing by one the following means.

1. High Compressive Strength Insert: On all insulated piping greater than 1-1/2", provide shield with high compressive strength insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:
 - a. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180-degree cylindrical segment the same length as metal shields. Inserts shall be:
 - b. Provide metal shields between hangers or supports and the pipe insulation/insert. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.
 - 1) Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5" to 6"	18" long x 16 gauge
8" to 14"	24" long x 14 gauge
16" to 24"	24" long x 12 gauge
 - c. Where rolled steel plate is noted above, provide minimum 1/4" rolled galvanized steel plates in addition to the shield as reinforcement on large pipes as noted above to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength.
2. Premanufactured Insulation Insert/Shield: As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.
 - a. Products:
 - 1) Buckaroo CoolDry
 - 2) Cooper/B-Line Fig. B3380 through B3384
 - 3) Pipe Shields A1000, A2000
3. Premanufactured Insulation Couplings:
 - a. Molded thermoplastic slip coupling, -65F to 275F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
 - b. PET thermoplastic foam load bearing core with elastomeric foam ends and lap-seal jacket.

- c. Horizontal Strut Mounted Insulated Pipe Manufacturers:
 - 1) Klo-Shure or equal
 - 2) Armafix Ecolight
 - d. Vertical Manufacturers:
 - 1) Manufacturers: Klo-Shure Titan or equal
 - 4. Premanufactured shield/saddle for use with Elastomeric Foam (Type B): molded thermoplastic rigid pipe saddle sized for insulation outside diameter. Length as required by manufacturer.
- B. Rectangular blocks, plugs, or wood material are not acceptable.
- C. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.
- D. Neatly finish insulation supports, protrusions, and interruptions.
- E. Ferrous hot piping 4 inches and larger, provide steel saddle at rollers as described in Section 230529 "HVAC Supports and Anchors".
- 3.4 INSULATION
- A. Type A Insulation:
- 1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
 - 2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
 - 3. Apply insulation with laps on top of pipe.
 - 4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60F, seal fitting covers with vapor retarder mastic in addition to tape.
- B. Type B Insulation:
- 1. Install per manufacturer's instructions or ASTM C1710.

2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Exterior installations shall contain factory applied polymeric, moisture, and UV resistant covering with ends sealed with adhesive and similar cover; or Contractor shall paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
 - a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
 - a. Install preformed sections of same material as straight segments of pipe insulation when available.
 - b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3.5 JACKET COVER INSTALLATION

A. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. All joints in areas noted shall meet USDA standards for Totally Sealed Systems, including overlaps of 1" on circumferential and 1.5" to 2" on longitudinal seams.
5. Use plastic insulation covering on all exposed pipes including, but not limited to:
 - a. All exposed piping in finished spaces unless noted otherwise on the drawings.
 - b. All exposed piping in locker rooms.
 - c. All exposed piping in kitchen areas.
 - d. All exposed piping adjacent to cloud ceilings.
 - e. All exposed piping in unfinished areas as noted on drawings (e.g., storage rooms, janitor's closets, utility rooms, etc.).
 - f. All exposed piping in mechanical or equipment rooms below 8'-0" above floor.
 - g. All exposed piping in mechanical rooms that is subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)

- h. All exposed piping in tunnels designated as passageways, equipment access, or egress.
- 6. Elastomeric piping insulation may have two coats of latex paint instead of plastic jacket.

3.6 SCHEDULE

- A. Refer to drawings for insulation schedule.

END OF SECTION

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Description
- B. Responsibilities
- C. Related Work
- D. Test Equipment

1.2 DESCRIPTION

- A. The purpose of this section is to specify Division 23 responsibilities in the commissioning process.
- B. The systems to be commissioned are listed in Section 019100.
- C. Commissioning requires the participation of the Division 23 Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 019100. Division 23 Contractor shall be familiar with all parts of Section 019100 and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.3 RESPONSIBILITIES

- A. Refer to Section 019100.

1.4 RELATED WORK

- A. Specific commissioning requirements are given in the following sections of these specifications. All the following sections apply to the Work of this section.
 - 1. Section 017823 - Operations and Maintenance
 - 2. Section 017900 - Demonstration and Training
 - 3. Section 019100 - Commissioning
 - 4. Section 210800 - Commissioning of Fire Suppression
 - 5. Section 220800 - Commissioning of Plumbing
 - 6. Section 260800 - Commissioning of Electrical
 - 7. Section 270800 - Commissioning of Communications
 - 8. Section 280800 - Commissioning of Electronic Safety and Security

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall provide all test equipment necessary to fulfill the testing requirements of this Division. This equipment includes, but is not limited to, the following:
 - 1. Handheld temperature and relative humidity meter.
 - 2. Infrared thermometer gun.
 - 3. Analog differential pressure gauge and associated tubing.
 - 4. Portable computer with access to the building automation system.
- B. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the related specifications. If not otherwise noted, the following minimum requirements apply:
 - 1. Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5F and a resolution of +/- 0.1F.
 - 2. Pressure sensors shall have an accuracy of +/- 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
 - 3. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.
- C. Refer to Section 019100 for additional Division 23 requirements.

PART 3 - EXECUTION

- A. Refer to Section 019100.

END OF SECTION

SECTION 230900 - CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Complete System of Automatic Controls.
- B. Control Devices, Components, Wiring and Material.
- C. Instructions for Owners.
- D. Remodeling.
- E. Critical Environment Controls (refer to Section 230920).

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years' experience.
- B. TCC: Company specializing in the work of this section with minimum five years temperature control experience.
- C. Technician: Minimum five years' experience installing commercial temperature control systems.
- D. TCCs are limited to firms regularly employing a minimum of five full-time temperature control technicians within 100 miles of the job site.

1.3 SUBMITTALS

- A. Equipment Coordination:
 - 1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
 - 2. Control valve selections shall be based on flow rates shown in approved shop drawings.
 - 3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.
- B. Shop Drawings:
 - 1. Submit shop drawings per Section 230500. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.
 - 2. Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.

3. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.
5. Diagrams shall include:
 - a. Wiring diagrams and layouts for each control panel showing all termination numbers.
 - b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
 - c. Identification of all control components connected to emergency power.
 - d. Schematic diagrams for all field sensors and controllers.
 - e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
 - f. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
 - g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
 - h. All installation details and any other details required to demonstrate that the system will function properly.
 - i. All interface requirements with other systems.
6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.
7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Architect/Engineer. Clearly highlight any deviations from the specified sequences on the submittals.

8. Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.
9. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:
 - a. Damper Identification Tag.
 - b. Location.
 - c. Damper Type.
 - d. Damper Size.
 - e. Duct Size.
 - f. Arrangement.
 - g. Blade Type.
 - h. Velocity.
 - i. Pressure Drop.
 - j. Fail Position.
 - k. Actuator Identification Tag.
 - l. Actuator Type.
 - m. Mounting.
10. Valve Schedule: Valve manufacturer shall size valves and create a valve schedule. Schedule shall include a separate line for each valve and a column for each of the valve attributes:
 - a. Valve Identification Tag.
 - b. Location.
 - c. Valve Type.
 - d. Valve Size.
 - e. Pipe Size.
 - f. Configuration.
 - g. Flow Characteristics.
 - h. Capacity.
 - i. Valve C_v .
 - j. Design Pressure Drop.
 - k. Pressure Drop at Design Flow.
 - l. Fail Position.
 - m. Close-off Pressure.
 - n. Valve and Actuator Model Number and Type.

11. Indoor modular air handling units (Section 237313) and mixed flow return air fans (Section 233413) provided under this project will have piezometer type sensors mounted at fan inlets by fan manufacturer. Fan manufacturer will provide fan specific flow coefficients and equations that can be used to calculate fan airflow based on measured pressure differential at fan inlet. TCC shall provide the following:
 - a. Quantity of pressure transducers so that each individual fan is served by a dedicated pressure transducer. Each pressure transducer shall have a range that is selected based on scheduled maximum airflow for each fan. TCC shall submit a schedule that shows the following calculations for each fan/pressure transducer:
 - 1) Pressure drop at maximum scheduled airflow for each fan using fan manufacturer's flow coefficient.
 - 2) Recommended transducer range.
 - b. Pneumatic tubing as required to interconnect all piezometer type sensors and pressure transducer. **Note: Where UV lamps are installed upstream of supply fan inlets, only copper tubing shall be used.**
 - c. Fasteners and supports as required to securely attached tubing, pressure transducers, conduits, wiring, and the like for a complete installation.
12. Airflow Measuring Station Schedule:
 - a. The manufacturer's authorized representative shall prepare the airflow measuring station submittal, or review and approve in writing the submittal prepared by the TCC prior to submission to the Architect/Engineer and prior to installation. The representative shall review air handling equipment submittals and duct fabrication drawings to ensure that all AFMS locations meet the appropriate parameters to achieve proper installation and the specified accuracy. Comply with all manufacturer's installation requirements including straight up and downstream duct lengths. Install airflow straighteners if required by the manufacturer based on installation constraints. The Architect/Engineer shall be notified for approval of any deviations.
 - b. Submit product data sheets for airflow measuring devices indicating minimum placement requirements, sensor density, sensor distribution, and installed accuracy to the host control system.
 - c. Submit installation, operation, and maintenance documentation.
13. Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer's description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer's literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.

14. Provide PICS files indicating the BACnet functionality and configuration of each device.
15. Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL), or provide a letter on the manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version that meets BTL testing and listing requirements if problems are found during BTL testing is required.
16. Graphic Display: Include a sample graphic of each system and component identified in the points list with a flowchart (site map) indicating how the graphics are to be linked to each other for system navigation.
17. Software: A list of operating system software, operator interface software, color graphic software, and third-party software.
18. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.
19. Clearly identify work by others in the submittal.
20. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

C. Operation and Maintenance Manual:

1. In addition to the requirements of Section 230500, submit an electronic copy of the O&M manuals in PDF format.
2. Provide three complete sets of manuals.
3. Each O&M manual shall include:
 - a. Table of contents with indexed tabs dividing information as outlined below.
 - b. Definitions: List of all abbreviations and technical terms with definitions.
 - c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
 - d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.
 - e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.
 - f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.
 - g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
 - h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.

- i. Original Software: Complete original issue CDs for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
- j. Software: One set of CDs containing an executable copy of all custom software created using the programming language, including the setpoints, tuning parameters, and object database.
- k. Graphics: A glossary or icon symbol library detailing the function of each graphic icon and graphics creation and modification. One set of CDs containing files of all color graphic screens created for the project.

D. Training Manual:

- 1. Provide a course outline and training manuals for each training class.

E. Record Documents:

- 1. Submit record documentation per Section 230500.
- 2. Provide a complete set of "as-built" drawings and application software on CDs. Provide drawings as AutoCAD™ or Visio™ compatible files. Provide two copies of the "as-built" drawings with revisions clearly indicated in addition to the documents on compact disk. All as-built drawings shall also be installed on the FMCS server in a dedicated directory. Provide all product data sheets in PDF format.
- 3. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.
- 4. Provide all completed testing and commissioning reports and checklists, along with all trend logs for each system identified in the points lists.
- 5. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the Architect/Engineer verifying completion and proper operation of all points.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.
- B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.5 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Control Valves.
- B. Flow Switches.
- C. Temperature Sensor Sockets.

- D. Gauge Taps.
- E. Automatic Dampers.
- F. Flow Meters.

1.6 AGENCY AND CODE APPROVALS

- A. All products shall have the following agency approvals. Provide verification that the approvals exist for all submitted products with the submittal package.
 - 1. UL-916; Energy Management Systems.
 - 2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "Signal Equipment."
 - 3. EMC Directive 89/336/EEC (European CE Mark).
 - 4. FCC, Part 15, Subpart J, Class A Computing Devices.

1.7 ACRONYMS

- A. Acronyms used in this specification are as follows:
 - 1. B-AAC BACnet Advanced Application Controller
 - 2. B-ASC BACnet Application Specific Controller
 - 3. BTL BACnet Testing Laboratories
 - 4. DDC Direct Digital Controls
 - 5. FMCS Facility Management and Control System
 - 6. GUI Graphic User Interface
 - 7. IBC Interoperable BACnet Controller
 - 8. IDC Interoperable Digital Controller
 - 9. LAN Local Area Network
 - 10. NAC Network Area Controller
 - 11. ODBC Open DataBase Connectivity
 - 12. OOT Object Oriented Technology
 - 13. OPC Open Connectivity via Open Standards
 - 14. PICS Product Interoperability Compliance Statement
 - 15. PMI Power Measurement Interface
 - 16. POT Portable Operator's Terminal
 - 17. TCC Temperature Control Contractor
 - 18. TCS Temperature Control System
 - 19. WAN Wide Area Network
 - 20. WBI Web Browser Interface

1.8 SUMMARY

- A. Extend Existing System:
 - 1. Extend the existing FMCS for this project.
 - 2. All controllers and accessories shall interface with the existing FMCS.

- B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management and Control System (FMCS) using Direct Digital Controls as shown on the drawings and as described herein.
- C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional cost to the Owner.
- D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.
- E. Provide Critical Environment Control System (refer to Section 230920

1.9 SYSTEM DESCRIPTION

- A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via the following protocol to an NAC. Temperature Control System products shall be as specified below.
- B. The FMCS shall include Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the Owner's local or wide area network, depending on configuration. Provide access to the system, either locally in each building or remotely from a central site or sites, through standard Web browsers, via the Internet, and/or via local area network.
- C. Provide materials and labor necessary to connect factory supplied control components.
- D. Provide central and remote hardware, software, and interconnecting wire and conduit.
- E. The FMCS shall include automated alarming software capable of calling e-mail compatible cellular telephones and pagers. The e-mail alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.
- F. For the dedicated configuration tool provided, it is preferable that it be launched from within the applicable Network Management Software. If not, include any software required for controller configuration as a leave-behind tool with enough license capability to support the installation.
- G. For each operator workstation provided, furnish one legal copy of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be readily available in the market. Contractor shall convey to the Owner all software tools and their legal licenses at project closeout.

H. Niagara Framework (Definition):

1. Niagara Framework: A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The framework consists of front end (M&C) software, web-based clients, field level control hardware, and engineering tools.
2. Niagara Framework Supervisory Gateway: DDC hardware component of the Niagara Framework. A typical Niagara architecture has Niagara-specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox protocol) and the field network beneath. These supervisory gateways may also be used as general-purpose controllers and also have the capability to provide a web-based user interface. Note that different vendors refer to this component by different names. The most common name is "JACE", which is used in this specification generically; other names include (but are not limited to) "EC-BOS", "FX-40", "TMN", "SLX" and "UNC".

I. Connection:

1. Wireless control systems/functions are acceptable.
 - a. Wireless System Architecture:
 - 1) The system communications between the network controller(s) and the thermostats shall be a wireless mesh network architecture.
 - 2) The wireless mesh network configuration must adhere to the IEEE 802.15.4 specification and operate in the band of 2.4GHz as a frequency hopping, spread spectrum network.
 - 3) The wireless mesh network shall constitute a wireless communications path between the wireless coordinator(s) and wireless thermostat backplates.
 - 4) The line of site (LOS) range from a wireless coordinator and the wireless thermostat backplate shall be specified at 3,000 feet or greater, and the LOS range from backplate to backplate shall be specified at 1,000 ft.
 - 5) Each wireless thermostat backplate shall incorporate wireless mesh network 'hopping' technology, allowing the communications to 'hop' from one backplate to the next.
 - 6) The wireless mesh network configuration must be 'self-healing', attempting to finding alternate paths to the end destination of the communications in the event a known primary path is unavailable.

- 7) Contractor is responsible to add all equipment necessary (e.g., repeaters) to make system complete and operating. Wireless repeaters shall extend the range of the mesh network and shall provide multiple data routes. Repeaters shall have 15 user-selectable channels. Wireless repeaters shall support up to 15 devices. Power requirements shall be 110 VAC standard outlet (converted to 3.3 VDC by repeater internal adaptor) or 5-30 VDC external DC power supply. Operating frequency band shall be 2.4 GHz ISM Band. Repeaters shall be equipped with omni-directional dipole antennas at 2.4 to 2.5 GHz. Units shall operate at 32F to 122F conditions.
- b. Components allowed for wireless:
 - 1) Room sensors (e.g., thermostats, RH, CO2).
 - 2) Application specific controllers.
 - 3) Insert
- c. Spaces/areas where wireless is not allowed:
 - 1) Pharmacy
 - 2) Cleanroom
 - 3) Data center
 - 4)
- d. Battery shall be replaceable with expected operating life of 15 years based on 30-second transmission frequency.
- e. Wireless Testing: The Contractor shall conduct all system testing. This shall include all calibration and adjustments of equipment controls, troubleshooting, and final adjustments or corrective action that may be required to provide a complete system that provides the specified performance and all required system features and functions listed herein and as further detailed on the drawings.
 - 1) At a minimum, the installer shall perform the following inspections and tests of the installed wireless controls system:
 - a) Verify that all features and functionality are operating properly.
 - b) Verify that the system receives signal from source and synchronizes all devices as specified. If not, Contractor is responsible to add all equipment necessary (e.g., repeaters) to make system complete and operating.
 - c) Verify that each device receives proper signals.
 - d) Verify that all controls are properly labeled and interconnecting wires and terminals are identified.

1.10 SOFTWARE LICENSE AGREEMENT

- A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job-specific configuration documentation, data files, configuration tools, and application-level software developed for the project. This shall include, but is not limited to, all custom, job-specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN/WAN/intranet and/or Internet connected routers and devices. Provide the Owner with all required IDs and passwords for access to any component or software program. The Owner shall determine which organizations shall be named in the SI organization ID ("orgid") of all software licenses. Owner shall be free to direct the modification of the "orgid" in any software license, regardless of supplier.
- B. For Niagara based systems, it is the express goal of this specification to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s).
 - 1. All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In", and "Tool Compatibility Out". Note that this will result in the following entries in the license file:
 - a. `accept.station.in="*"`
 - b. `accept.station.out="*"`
 - c. `accept.wb.in="*"`
 - d. `accept.wb.out="*"`
 - 2. The Owner shall be free to direct the modification of the any software license, regardless of supplier. In addition, the Owner shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job-specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use within Niagara Framework (Niagara)-based controllers and/or servers and any related LAN/WAN / intranet and internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the Owner. Provide all software necessary for developing software algorithms in all supervisory, programmable, and application specific direct digital controllers that are licensed to the Owner.
 - 3. Programming tools for programmable and application specific controllers that use the Niagara Framework shall not be restricted to any specific brand of JACE. Tools and controllers shall be able to connect to any brand of JACE that are provided under this specification section.

- a. For each application generic controller with a Niagara Framework Wizard and for each application specific controller, provide Niagara Framework Wizards.
 - b. For each Niagara Framework Supervisory Gateway, provide a backup of all software within the Niagara Framework Supervisory Gateway, including configuration settings. This backup must be sufficient to allow restoration of the Niagara Framework Supervisory Gateway or the replacement of the Niagara Framework Supervisory Gateway.
 - c. Provide a Niagara Framework Engineering Tool. Submit software user manuals with the Niagara Framework Engineering Tool submittal.
 - d. Provide the Niagara Station ID for each Niagara Framework Supervisory Gateway.
- C. The energy metering system is a Tridium-based system using JACE's with I/O modules for single inputs and direct communications to meters that provide multiple points of data. All meters, metering points, and wiring are furnished and installed by the TCC.

1.11 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

1.12 WARRANTY

- A. Refer to Section 230500 for warranty requirements.
- B. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.
- C. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.
- D. Update all software and back-ups during warranty period and all user documentation on the Owner's archived software disks.

1.13 WARRANTY ACCESS

- A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. BACnet Protocol with Tridium Niagara Platform:

1. Trane Tracer SC

2.2 SYSTEM ARCHITECTURE

A. General:

1. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall consist of a network of interoperable, standalone digital controllers, a computer system, graphic user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.
2. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.

B. Open, Interoperable, Integrated Architectures:

1. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data are not acceptable.
2. The supplied system must be able to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs are not acceptable.
3. Hierarchical or "flat" topologies are required to have system response times as indicated below and to manage the flow and sharing of data without unduly burdening the customer's internal intranet network.
 - a. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - b. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.3 NETWORKS

A. The Local Area Network (LAN) shall be a 100 megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP. Provide support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE Standard 802.3.

2. Cable; 100 Base-T, UTP-8 wire, Category 6.
 3. Minimum throughput; 100 Mbps.
- C. Communication conduits shall not be installed closer than six feet from 110VAC or higher transformers or run parallel within six feet of electrical high-power cables. Route the cable as far from interference generating devices as possible. Where communication wire must cross 110VAC or higher wire, it must do so at right angles.
- D. Ground all shields (earth ground) at one point only to eliminate ground loops. Provide all shield grounding at the controller location, with the shield at the sensor/device end of the applicable wire being left long and "safed" off in an appropriate manner.
- E. There shall be no power wiring more than 30 VAC rms run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, run all communication wiring and signal wiring using separate twisted pairs (24awg) in accordance with the manufacturer's wiring practices.

2.4 BACNET FMCS

- A. The intent of this specification is to provide a peer-to-peer networked, standalone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices in the system. Adherence to industry standards including the latest ANSI/ASHRAE Standard 135 (BACnet) to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP) and/or RS-485 (BACnet MSTP).
- C. Interoperable BACnet Controller (IBC):
1. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the latest ANSI/ASHRAE Standard 135. Provide IBCs for unit ventilators, fan coils, heat pumps, terminal air boxes (TAB) and other applications. The application control program shall reside in the same enclosure as the input/output circuitry that translates the sensor signals. Provide a PICS document showing the installed system's compliance level to ANSI/ASHRAE Standard 135. Minimum compliance is Level 3.
 2. The IBCs shall be listed by the BACnet Testing Laboratory (BTL) as follows:
 - a. BACnet Building Controller(s) (B-BC).
 - b. BACnet Advanced Application Controller(s) (B-AAC).
 - c. BACnet Application Specific Controller(s) (B-ASC).
 3. The IBCs shall communicate with the NAC.

4. Each IBC sensor shall connect directly to the IBC and shall not use any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
5. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable) require a 10% spare point capacity to be provided for all applications. Store all control sequences within or programmed into the IBC in non-volatile memory that does not depend on a battery to be retained.
6. The Contractor supplying the IBCs shall provide documentation for each device, with the following information at a minimum:
 - a. BACnet Device; MAC address, name, type and instance number.
 - b. BACnet Objects; name, type and instance number.
7. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each IBC.

D. Object Libraries:

1. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
2. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
3. In addition to the standard libraries specified here, the system supplier shall maintain an on-line accessible (over the Internet) library, available to all registered users, to provide new or updated objects and applications as they are developed.
4. All control objects shall conform to the control objects specified in the BACnet specification.
5. The library shall include applications or objects for the following functions, at a minimum:
 - a. Scheduling Object: The schedule must conform to the schedule object as defined in the BACnet specification, providing seven-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphic sliders to speed creation and selection of on-off events.
 - b. Calendar Object: The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphic "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.

- c. **Override Object:** Provide override object that is capable of restarting equipment turned off by other energy saving programs to maintain occupant comfort or for equipment protection.
 - d. **Start-Stop Time Optimization Object:** Provide a start-stop time optimization object to start equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled unoccupied time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start-stop time object properties based on historical performance.
 - e. **Demand Limiting Object:** Provide a demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, gas, etc.). The object shall be able to monitor a demand value and predict (using a sliding window prediction algorithm) the demand at the end of the user-defined interval period (1 to 60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user-defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment setpoints to provide the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the setpoint, display a message on the user's screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to provide both equipment protection and occupant comfort.
6. The library shall include control objects for the following functions:
- a. **Analog Input Object:** Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 - b. **Analog Output Object:** Minimum requirement is to comply with the BACnet standard for data sharing.
 - c. **Binary Input Object:** Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment runtime by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.

- d. Binary Output Object: Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as start-to-start delay must be provided. Incorporate the BACnet Command Prioritization priority scheme to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide 16 levels of priority as a minimum. Systems not employing the BACnet method of contention resolution are not acceptable.
- e. PID Control Loop Object: Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable to allow proportional control only, or proportional with integral control, or proportional, integral and derivative control.
- f. Comparison Object: Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
- g. Math Object: Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
- h. Custom Programming Objects: Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including, but not limited to, math and logic functions and string manipulation. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for reuse.
- i. Interlock Object: Provide an interlock object that provides a means of coordination of objects within a piece of equipment, such as an air handler or other similar types of equipment. An example is to link the return fan to the supply fan such that, when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming, thereby eliminating nuisance alarms during the off period.
- j. Temperature Override Object: Provide an object whose purpose is to override a binary output to an "on" state in the event a user-specified high or low limit value is exceeded. Link this object to the desired binary output object as well as to an analog object for temperature monitoring to cause the override to be enabled. This object will execute a start command at the Temperature Override level of start/stop command priority, unless changed by the user.

- k. Composite Object: Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphic shell of this container.
7. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). Provide the following as part of the standard library included with the programming software:
- a. LonMark/LonWorks Devices: These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. Support all network variables defined in the LonMark profile. The device manufacturer shall provide information (type and function) regarding network variables not defined in the LonMark profile.
 - b. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file, and documentation for the device to facilitate device integration.
 - c. For BACnet devices, provide the following objects:
 - 1) Analog In.
 - 2) Analog Out.
 - 3) Analog Value.
 - 4) Binary.
 - 5) Binary In.
 - 6) Binary Out.
 - 7) Binary Value.
 - 8) Multi-State In.
 - 9) Multi-State Out.
 - 10) Multi-State Value.
 - 11) Schedule Export.
 - 12) Calendar Export.
 - 13) Trend Export.
 - 14) Device.
 - d. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
 - e. For BACnet devices, provide the following support at a minimum:
 - 1) Segmentation.
 - 2) Segmented Request.
 - 3) Segmented Response.
 - 4) Application Services.
 - 5) Read Property.
 - 6) Read Property Multiple.
 - 7) Write Property.
 - 8) Write Property Multiple.

- 9) Confirmed Event Notification.
- 10) Unconfirmed Event Notification.
- 11) Acknowledge Alarm.
- 12) Get Alarm Summary.
- 13) Who-has.
- 14) I-have.
- 15) Who-is.
- 16) I-am.
- 17) Subscribe COV.
- 18) Confirmed COV notification.
- 19) Unconfirmed COV notification.
- 20) Media Types.
- 21) Ethernet.
- 22) BACnet IP Annex J.
- 23) MSTP.
- 24) BACnet Broadcast Management Device (BBMD) function.
- 25) Routing.

2.5 TERMINAL AIR BOX (TAB) CONTROLLERS

- A. FMCS Volume Controller: Electronic, furnished and installed by TCC. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Provide velocity and static sensor at box inlet for use by unit controller. Set boxes for maximum and minimum settings shown on the drawings. Refer to Section 233600 for additional information.
- B. The controller shall support various digital and analog inputs and outputs as needed for damper control, control valves, electric coils, airflow sensors, remote heating, occupancy sensors, etc. and shall be capable of independent occupancy scheduling.
- C. Controller shall provide continuous zone temperature histories internal to device for up to 24 hours and perform its own limit and status monitoring and alarms to limit unnecessary communications.
- D. Operator interface to any ASC point data or programs shall be through network resident programs or portable operator's terminal connected to the specific controller.
- E. Store all system setpoints, proportional bands, control algorithms, and other programmable parameters such that a power failure of any duration does not necessitate reprogramming of the controller.
- F. BACnet TAB controllers shall either be B-AAC devices or B-ASC devices as required to meet the performance and BTL listing.

2.6 DATA COLLECTION AND STORAGE (TRENDING REQUIREMENTS)

- A. The NAC shall be able to collect data for any property of any object and store resident in the NAC that shall have, at a minimum, the following configurable properties:
 1. Designating the log as interval or deviation.

2. For interval logs, configure the object for time of day, day of week and the sample collection interval.
 3. For deviation logs, configure the object for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full or rollover the data on a first-in, first-out basis.
 5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
- B. Store all log data in a relational database in the NAC that is accessible from a server (if the system is so configured) or a standard Web browser.
- C. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- D. All log data shall be available to the user in ALL the following data formats:
1. HTML.
 2. XML.
 3. Plain text.
 4. Comma or tab separated values.
- E. The NAC shall archive its log data either locally (to itself) or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties:
1. Archive on time of day.
 2. Archive on user-defined number of data stores in the log (buffer size).
 3. Archive when log has reached its user-defined capacity of data stores.
 4. Provide ability to clear logs once archived.
- 2.7 AUDIT LOG
- A. Provide and maintain an audit log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
1. Time and date.
 2. User ID.
 3. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.
- 2.8 DATABASE BACKUP AND STORAGE
- A. The NAC shall automatically backup its database on a user-defined time interval.
- B. Store copies of the current database and, at the most, the recently saved database in the NAC. The age of the most recently saved database shall depend on the user-defined database save interval.

- C. Store the NAC database in XML format to allow viewing and editing. Other formats are acceptable as long as XML format is supported.

2.9 GRAPHIC USER INTERFACE SOFTWARE

A. Operating System:

1. Provide computer with the most current Microsoft-based operating system with which the GUI has proven compatibility.

- B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu pulldowns and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line) that displays the location and the selected object identification.

- C. Point Organization: Organize points by equipment categories, location, or other means acceptable to Owner.

D. Real-Time Displays: The GUI shall support the following graphic features and functions:

1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file. Use of proprietary graphic file formats is not acceptable. In addition to, or in lieu of, a graphic background, the GUI shall support the use of scanned pictures.
2. Graphic screens shall be able to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.
3. Graphics shall support layering, and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
4. Modifying common application objects, such as schedules, calendars, and setpoints, shall be accomplished graphically.
 - a. Schedule times shall be adjusted using a graphic slider without requiring any keyboard entry from the operator.
 - b. Holidays shall be set by using a graphic calendar without requiring any keyboard entry from the operator.
5. Commands to start and stop binary objects shall be made by selecting the object and the appropriate command from a pop-up menu. No text entry shall be required.
6. Adjustments to analog objects, such as setpoints, shall be made by selecting the object and using a graphic slider to adjust the value. No text entry shall be required.

- E. System Configuration: At a minimum, the GUI shall include the necessary software and components to enable the operator to perform the following tasks with proper password access:

1. Create, delete or modify control strategies.
 2. Add/delete objects.
 3. Tune control loops by adjusting control loop parameters.
 4. Enable or disable control strategies.
 5. Generate hard copy records or control strategies on a printer.
 6. Select alarm points and define the alarm state.
 7. Select points to be trended and initiate the recording of values automatically.
 8. View any trend as a graph.
- F. On-Line Help: Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available using hypertext. All system documentation and help files shall be in HTML format.
- G. Security: Each operator shall be required to log on to that system with a user name and password to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall be able to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operator's access for viewing and/or changing each system application, full screen editor, and object. Each operator shall be automatically logged off the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. Store all system security data in an encrypted format.
- H. System Diagnostics: The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. Annunciate the failure of any device to the operator.
- I. Alarm Console:
1. The system shall have a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and to acknowledge the alarm.
 2. When the alarm console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator are not acceptable. The use of the alarm console can be enabled or disabled by the system administrator.
- 2.10 WEB BROWSER CLIENTS
- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser. Systems requiring additional software to enable a standard Web browser to reside on the client machine, or manufacturer-specific browsers, are not acceptable.

- B. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphic User Interface. Systems that require different views or that require different means of interacting with objects, such as schedules or logs, are not permitted.
- C. The Web browser client shall provide:
 - 1. User log-on identification and password shall be required. If an unauthorized user attempts access, display a blank web page. Implement security using Java authentication and encryption techniques to prevent unauthorized access.
 - 2. Graphic screens developed for the GUI shall be the same screens used for the Web browser client. The web browser interface shall support all animated graphic objects supported by the GUI.
 - 3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - 4. Store all graphic screens in the Network Area Controller (NAC) without requiring any graphics storage on the client machine.
 - 5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
 - 6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify common application objects, such as schedules, calendars, and setpoints, graphically.
 - 1) Schedule times shall be adjustable using a graphic slider, without requiring any keyboard entry from the operator.
 - 2) Holidays shall be set using a graphic calendar, without requiring any keyboard entry from the operator.
 - b. Commands to start and stop binary objects shall be made by right-clicking the selected object and selecting the appropriate command from a pop-up menu. No text entry shall be required.
 - c. View logs and charts.
 - d. View and acknowledge alarms.
 - e. Setup and execute SQL queries on log and archive information
 - 7. The system shall be able to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just his/her defined home page. From the home page, links to other views or pages in the system shall be possible, if allowed by the system administrator.
 - 8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on intranet sites by specifying the Uniform Resource Locator (URL) for the desired link.

2.11 UNINTERRUPTIBLE POWER SUPPLY (UPS)

- A. A UPS shall be provided for each of the following:
 - 1. FMCS workstations and servers.
 - 2. Network area controllers.
 - 3. Chiller plant manager (including refrigerant monitor).
 - 4. Boiler plant manager.
 - 5. Smoke control system controllers (e.g., atrium smoke evac, stairwell pressurization, etc.)
- B. Provide a 120-volt 60 Hz line-interactive uninterruptible power supply with backup battery capacity for two (2) minutes at 100% load. UPS shall have hot swappable batteries, automatic battery self-test and start-on-battery capabilities. Batteries shall be valve regulated, sealed lead acid type. UPS shall have sine wave shape output waveform. UPS shall be UL 1778 list and comply with FCC Part 15, Class A.
- C. Manufacturers:
 - 1. Sola/Hevi-Duty
 - 2. Eaton Powerware
 - 3. APC

2.12 SYSTEM PROGRAMMING

- A. The GUI software shall perform system programming and graphic display engineering. Access to the GUI software shall be through password access as assigned by the system administrator.
- B. Provide a library of control, application, and graphic objects to enable creation of all applications and user interface screens. Applications shall be created by selecting the control objects from the library, dragging or pasting them on the screen, and linking them together using a built-in graphic connection tool. Completed applications may be stored in the library for future use. GUI screens shall be created in the same fashion. Data for the user displays shall be obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Provide all software tools or processes to create applications and user interface displays.
- C. Programming Methods:
 - 1. Provide the capability to copy objects from the supplied libraries or from a user-defined library to the user's application. Link objects with a graphic linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; e.g., internal, external, hardware, etc.

2. Configuration of each object shall be done through the object's property sheet using fill-in-the-blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration is not acceptable.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real time. Systems requiring the uploading, editing, and downloading of database objects are not allowed.
5. The system shall support object duplication in a customer's database. An application, once configured, can be copied and pasted for easy reuse and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.13 DDE DEVICE INTEGRATION

- A. The NAC shall support the integration of device data via Dynamic Data Exchange (DDE) over the Ethernet network. The NAC shall act as a DDE client to another software application that functions as a DDE server.
- B. Provide the required objects in the library included with the Graphic User Interface programming software to support the integration of these devices into the FMCS. Objects provided shall include, at a minimum:
 1. DDE Generic AI Object.
 2. DDE Generic AO Object.
 3. DDE Generic BO Object.
 4. DDE Generic BI Object.

2.14 MODBUS SYSTEM INTEGRATION

- A. The NAC shall support integration of device data from Modbus RTU, ASCII, and TCP control system devices. Connect to the Modbus system via an RS-232, RS485, or Ethernet IP as required by the device.
- B. Provide the required objects in the library included with the GUI programming software to support the integration of the Modbus system data into the FMCS. Objects provided shall include, at a minimum:
 1. Read/Write Modbus AI Registers.
 2. Read/Write Modbus AO Registers.
 3. Read/Write Modbus BI Registers.
 4. Read/Write Modbus BO Registers.
- C. The NAC shall perform all scheduling, alarming, logging and global supervisory control functions of the Modbus system devices.

- D. The FMCS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment using Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning.

2.15 OPC SYSTEM INTEGRATION

- A. The Network Area Controller shall act as an OPC client and shall support the integration of device data from OPC servers. The connection to the OPC server shall be Ethernet IP. The OPC client shall support third-party OPC servers compatible with the Data Access 1.0 and 2.0 specifications.
- B. Provide the required objects in the library included with the GUI programming software to support the integration of the OPC system data into the FMCS. Objects provided shall include:
 - 1. Read/Write OPC AI Object.
 - 2. Read/Write OPC AO Object.
 - 3. Read/Write OPC BI Object.
 - 4. Read/Write OPC BO Object.
 - 5. Read/Write OPC Date/Time Input Object.
 - 6. Read/Write OPC Date/Time Output Object.
 - 7. Read/Write OPC String Input Object.
 - 8. Read/Write OPC String Output Object.
- C. The NAC shall perform all scheduling, alarming, logging and global supervisory control functions of the OPC system devices.
- D. The FMCS supplier shall provide an OPC client communications driver. The vendor that provided the equipment using OPC shall provide documentation of the system's OPC server interface and shall provide free factory support during system commissioning.

2.16 SOFTWARE

- A. IDC/IBCs shall operate totally standalone and independent of a central computer for all specified control applications.
- B. Software shall include a complete operating system (OS), communications handler, point processing, energy management application packages as specified herein, standard control algorithms and specific control sequences (IDC/IBC) and an Owner/user custom control calculation package complete with interpreter.
- C. OS software shall be PROM resident, operate in real time, provide prioritized task scheduling, control time programs, monitor and manage communications, and scan inputs and outputs.
- D. Each IDC/IBC panel shall include the following energy management routines:
 - 1. Time of day scheduling.
 - 2. Optimum start/stop.

3. Peak demand limiting.
 4. Economizer control.
 5. PID control.
 6. Supply air reset.
 7. Outdoor air reset.
- E. Input/output point processing software shall include:
1. Update of all connected input and output points at least once per second.
 2. Analog to digital conversion, scaling and offset, correction of sensor non-linearity, sensing no response or failed sensors, and conversion of values to 32-bit floating point format. Retain both the maximum and minimum values sensed for each analog input in memory. It shall be possible to input subsets of standard sensor ranges to the A/D converter and assign gains to match the full-scale 32-bit conversion to achieve high accuracy readout.
 3. A reasonability check on all analog inputs against previous values and discarding of values falling outside preprogrammed reasonability limits.
 4. Assignment of proper engineering units and status conditions to all inputs and outputs.
 5. Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and alarm) to an input or to assign a set of floating limits (alarm a reset schedule or FMCS control point) to the input. Assign each alarm a unique differential to prevent a point from oscillating in and out of alarm. Make alarm comparisons of each scan cycle.
 6. Adjustment of timing from two seconds to two minutes in one-second increments to eliminate nuisance alarms on startup.
- F. Command Control software shall manage the receipt of commands from the server and from control programs.
1. Provide command delay to prevent simultaneous energizing of loads. Delay must be programmable from 0 to 30 seconds.
 2. Assign each command a command and residual priority to manage conflicts created by multiple programs having access to the same command point. Allow only outputs with a higher command priority to execute. Whenever a command is allowed to execute, its assigned residual priority shall replace the existing residual priority.
 3. A "fixed mode" option (override) shall allow inputs to and outputs from control programs to set to a fixed state or value. When in the "fixed mode", assign inputs and outputs high residual command priority to prevent override by application programs.
- G. Alarm lockout software shall prevent nuisance alarms. On initial start-up of mechanical equipment, assign a "timed lockout" period to analog points to allow them to reach a stable condition before activating alarm comparison logic. Lockout period shall be programmable for each point from 0 to 90 minutes in one-minute increments.
- H. A "hard lockout" shall also be provided to positively lock out alarms when equipment is turned off or when a true alarm depends on the condition of an associated point. Hard lockout points and lockout initiators shall be operator programmable.

- I. Runtime shall be accumulated based on the status of a digital input point. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Runtime counts shall reside in non-volatile memory and have DCP resident runtime limits assignable through the operator's terminal.
- J. A transition counter shall count the number of times a device is cycled on or off. Counter shall be non-volatile and capable of counting 600,000 cycles. Limits shall be assignable to counts to provide maintenance alarm printouts.
- K. Custom IDC/IBC programs shall meet the control strategies called for in the sequence of operation of these specifications. Each IDC/IBC shall have resident in its memory and available to the programs a full library of IDC/IBC algorithms, intrinsic control operators, arithmetic, logic, and relational operators. Provide the following features:
 - 1. Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and Adaptive Control (self-learning). Use Adaptive Control where the controlled flow rate is variable (such as TAB units and variable flow pumping loops). The adaptive control algorithm shall monitor the loop response to output corrections and adjust the loop response characteristics in accordance with the time constant changes imposed by variable flow rates. The algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of the system dynamics so that, on system shutdown and restart, the learning process starts from where it left off. Standard PID algorithms are not acceptable substitutes for variable flow applications since they will provide satisfactory control at only one flow rate and will require continued manual fine tuning.
 - 2. All IDC/IBC setpoints, gains and time constants associated with IDC/IBC programs shall be available to the operator for display and modification via the operator workstation.
 - 3. The execution interval of each IDC/IBC loop shall be adjustable from 2 to 120 seconds in one-second increments.
 - 4. IDC/IBC control programs shall assign initialization values to all outputs so controlled devices assume a failsafe position on start-up.
- L. Provide time and event programming (TEP) capability to initiate a controlled sequence of events for execution at a specific time or upon the occurrence of an event. Minimum program features required are:
 - 1. Analog points commandable to a specific value.
 - 2. Digital points commandable to a specific state; e.g. on or off; fast, slow or off.
 - 3. Initiator to be a specific day and time or a specific event; e.g. an alarm.
 - 4. Manual initiation via operator's command.
 - 5. Commands must honor command delays (to prevent current surges), and assigned minimum ON and OFF times.
 - 6. Commands must honor command and residual priority structures allowing higher priority commands (like smoke control) to override lower priority commands (like time of day scheduling) and residual priority.
 - 7. Ability to chain TEPs.
 - 8. Ability to enable and disable TEPs individually.
 - 9. Ability to enable/disable TEP initiators.

- M. Store Energy Management application programs and associated data files in non-volatile or 72-hour battery backed RAM memory. Individual programs shall be accessible from the operator workstation for enabling/disabling and program parameter modification and shall include:
1. Time Programs:
 - a. Provide an independent start and stop program time for each system identified in the points list.
 - b. It shall be possible to assign two independent start and stop times/days to any equipment connected to a controller.
 2. Exception Day Scheduling:
 - a. Provide an Exception Day program for holiday and other planned exceptions to time programs. Exception schedules shall be DSC resident and operator programmable up to one year in advance.
 - b. The program shall allow definition of up to 32 exception time spans. Define each span by calendar start day and calendar stop day.
 3. An IDC/IBC resident temporary scheduler shall allow operators to modify present time program control of equipment. Minimum feature set required is:
 - a. Ability to alter time schedules as much as six days in advance.
 - b. Ability to alter either start time, stop time or both for each day.
 - c. Temporary schedule shall be in effect for all days specified.
 - d. Automatically delete the temporary schedule and restore program to normal schedule after execution.
 - e. Ability to assign schedule changes as permanent as well as temporary.
- N. The IDC/IBC shall have built-in, non-descriptive, self-test procedure for checking the indication lights, digital display, and memory. It shall display advisories for maintenance, performance, and/or software problems.
- O. All electronics shall be:
1. Standard locally stocked modular boards.
 2. Plug-in type.
 3. Furnish all ROM programs unlocked.
- 2.17 VARIABLE FREQUENCY DRIVES
- A. Refer to Section 230515 Variable Frequency Drives for additional information.
 - B. Power connection between VFD and motor shall be by EC. Coordinate feeder and raceway installation with EE.

2.18 CONTROL DAMPERS

A. Rectangular Control Dampers - Standard Construction:

1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Hat-shaped channel, minimum 12 gauge extruded aluminum, and minimum 4" deep. Caulk or weld seams to prevent leakage.
4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide, and overlapping blades and blade seals (overlapping blade seals only is unacceptable).
5. Shaft: Non-cylindrical, solid aluminum or zinc plated steel with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
7. Blade Seals: Extruded silicone gaskets secured in an integral slot within the blade.
8. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
9. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
10. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
11. Maximum Leakage: Class 1A at 1" w.c. pressure differential for a 24" x 24" damper.
12. Maximum Pressure Drop for Opposed Blade Damper: 0.15" for 8000 CFM through a 24" x 24" damper (2000 fpm).
13. Maximum Pressure Drop for Parallel Blade Damper: 0.08" for 8000 CFM through a 24" x 24" damper (2000 fpm).

B. Thermally Insulated Control Damper:

1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Extruded aluminum, minimum 4" deep, 0.080" minimum thickness.
4. Thermally Broken Frame: Extruded aluminum, minimum 4" deep, 0.080" minimum thickness, flanged to duct. Entire frame shall be thermally broken using polyurethane resin pockets, complete with thermal cuts.
5. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide, internally insulated with expanded polyurethane foam and thermally broken, with overlapping blades and blade seals (overlapping blade seals only is unacceptable).

6. Shaft: Non-cylindrical, solid aluminum or zinc plated steel shaft with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
7. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
8. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
9. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
10. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
11. Maximum Leakage: Class 1A at 1" w.c. pressure differential for a 24" x 24" damper.
12. Maximum Pressure Drop: 0.21" for 8000 CFM through a 24" x 24" damper (2000 fpm).

C. Round Galvanized Steel Control Dampers:

1. Test leakage and pressure drop per AMCA 500.
2. Frame: Minimum 20 gauge galvanized steel, 10" long.
3. Bearings: Provide thrust bearings for vertical damper applications.
4. Blades: Two-layer galvanized steel, equivalent 14 gauge thickness with neoprene or polyethylene foam seal enclosed in two-piece blade construction up to 24", 10 gauge steel over 24".
5. Linkage: Stainless steel, minimum 1/2" diameter shaft through 24", 3/4" shaft over 24" size. Stainless steel bearings. Shaft shall be securely keyed to blades and of sufficient length to mount direct-coupled actuator. Install damper with the shaft horizontal to the floor. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
6. Maximum Leakage: 8 CFM maximum at 1" w.c. pressure differential for a 24" x 24" damper.
7. Maximum Pressure Drop: 0.10" for 6280 CFM through a 24" damper (2000 fpm).

D. Round Stainless Steel Control Dampers:

1. Test leakage and pressure drop per AMCA 500.
2. Frame: Hat-shaped channel, minimum 10 gauge Type 304 stainless steel (304L or 316L for welded duct). Caulk or weld seams to prevent leakage.
3. Bearings: Provide thrust bearings for vertical damper applications.
4. Blades: Minimum 12 gauge Type 304 stainless steel construction. No seals are required.

5. Linkage: Stainless steel, minimum 1/2" diameter shaft through 12", 3/4" shaft through 24", 1" shaft over 24" size. Stainless steel bearings. Shaft shall be securely keyed to blades and of sufficient length to mount direct-coupled actuator. Install damper with the shaft horizontal to the floor. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
6. Maximum Leakage: 26 CFM maximum at 1" w.c. pressure differential for a 24" x 24" damper.
7. Maximum Pressure Drop: 0.15" for 6280 CFM through a 24" damper (2000 fpm).

2.19 DAMPER ACTUATORS

A. Damper Actuators - Electronic:

1. Actuator shall be UL 873 or 60730 listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation. Mount actuator by means of a V-bolt dual nut clamp with a V-shaped toothed cradle, directly couple and mount to the valve bonnet stem, or ISO-style direct-coupled mounting pad. Actuators shall be capable of being mechanically and electrically paralleled to increase torque, if required.
2. Actuators shall be warranted for a period of five (5) years from the date of production, with the first two (2) years unconditional.
3. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
4. Fail-Safe Dampers: Where shown on the drawings or sequences, fail-safe mechanism shall operate the damper to the fail position following power interruption.
 - a. Mechanical/Spring: Mechanical spring return mechanism to drive controlled drive to an end position (open or close) on loss of power.
 - b. Electronic: Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the capacitors. The power fail position shall be proportionally adjustable between 0% and 100% in 10 percent increments with a 10 second operational delay.
5. Feedback: Where shown on drawings or sequences, provide analog feedback signal for positive position indication.
6. Damper End Switches: Where shown on the drawings or sequences, provide end switches to prove damper reaches open/closed position.

2.20 HYDRONIC CONTROL VALVES

A. General:

1. Two-position valves shall be a minimum of line size with a maximum allowable pressure drop of 1 psi.
2. Size two-way and three-way modulating valves to provide a pressure drop at full flow of 4 to 5 psi, except boiler three-way and cooling tower bypass valves shall not have a pressure drop over 4 psi.
3. Modulating two-way valves shall have equal percentage flow characteristics.
4. Modulating three-way valves shall have linear flow characteristics.

5. Piping geometry correction factors for C_v ratings shall be used and stated for ball valves, butterfly valves, or non-characterized valves.

B. Modulating:

1. Ball 2" and under:
 - a. Design Pressure: 400 psi
 - 1) Design Temperature: 250F
 - 2) Design Flow Differential Pressure Rating: 35 psi
 - 3) Leakage: 0%
 - b. Bronze or brass body, nickel plated brass or stainless steel stem, chrome plated brass or stainless steel ball, EPDM, PTFE or RTFE seats and seals, V-Port ball or PTFE characterizing disc, screwed ends.
2. Ball 2-1/2" to 6":
 - a. Design Pressure: 200 psi
 - 1) Design Temperature: 212F
 - 2) Design Flow Differential Pressure Rating: 35 psi
 - 3) Leakage: 0%
 - b. Cast iron body GG25, stainless steel stem, stainless steel ball, EPDM, PTFE or RTFE seats and seals, V-Port ball or stainless steel characterizing disc, flanged ends.
3. Butterfly 2-1/2" to 12":
 - a. Design Pressure: 125 psi
 - 1) Design Temperature: -20F to 212F
 - 2) Design Flow Differential Pressure Rating: 50 psi
 - b. Cast iron body, stainless steel stem with extended neck, aluminum-bronze or nickel-plated iron disc, EPDM seats and seals, fully lugged ends.

2.21 VALVE ACTUATORS

A. General:

1. Actuators shall be sized to operate the valve through its full range of motion and shall close against pump shutoff pressure without producing audible noise at any valve position.
2. Provide visual position indication.
3. Mount actuator directly on valve or provide linear motion assembly as required for valve type.

B. Valve Actuators - Electronic:

1. Actuator shall be UL 873 or 60730 listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation. Mount actuator by means of a V-bolt dual nut clamp with a V-shaped toothed cradle, directly couple and mount to the valve bonnet stem, or ISO-style direct-coupled mounting pad. Actuators shall be capable of being mechanically and electrically paralleled to increase torque, if required.
2. Actuators shall be warranted for a period of five (5) years from the date of production, with the first two (2) years unconditional.
3. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
4. Fail-Safe Valves: Where shown on the drawings or sequences, fail-safe mechanism shall operate the valve to the fail position following power interruption.
 - a. Mechanical/Spring: Mechanical spring return mechanism to drive controlled drive to an end position (open or close) on loss of power.
 - b. Electronic: Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the capacitors. The power fail position shall be proportionally adjustable between 0% and 100% in 10 percent increments with a 10 second operational delay.
5. Feedback: Where shown on drawings or sequences, provide analog feedback signal for positive position indication.

2.22 CONTROL INSTRUMENTATION

A. Temperature Measuring Devices:

1. Electric Thermostats:
 - a. Single Temperature - Line Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5F, concealed temperature adjustment, locking cover, rated for load, single or double pole as required.
 - b. Single Temperature - Low Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5F, anticipator circuits, concealed temperature adjustment, locking cover, 24 V control transformer (if not included with unit under control), single or double pole as required.
2. Low Limit Switch:
 - a. Provide one foot of sensing element for each one square foot of coil area, maximum element length 25 feet, of the vapor tension type, so that any point along the entire length of measuring element can trigger the switch.
 - b. Provide 3" minimum radius capillary support clips at each turn.
 - c. Furnish each thermostat with one single pole, single throw normally-opened switch and one single pole, single throw normally-closed auxiliary switch.
 - d. Setpoint range shall be 15F to 55F, with a permanent stop at 35F.

- e. Differential shall be fixed at approximately 5F and supplied with manual reset.

B. Temperature Sensors:

1. Room Temperature Sensor:

- a. Sensor Only: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45F to 90F operating range, $\pm 0.50F$ accuracy, no setpoint adjustment or override button.
- b. Sensor with Setpoint Adjustment: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45F to 90F operating range, $\pm 0.50F$ accuracy, with exposed single setpoint adjustment (no numeric temperature scale - provide with a single warmer/cooler or red/blue visual scale), no override button.
- c. Sensor with Override: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45F to 90F operating range, $\pm 0.50F$ accuracy, occupied/unoccupied override button with LED, no setpoint adjustment.
- d. Sensor with Setpoint Adjustment and Override: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45F to 90F operating range, $\pm 0.50F$ accuracy, with exposed single setpoint adjustment (no numeric temperature scale - provide with a warmer/cooler or red/blue visual scale), occupied/unoccupied override button with LED.

2. Duct Temperature Sensor:

- a. RTD type averaging sensor. 1000 ohm platinum RTD; accuracy: minimum $\pm 1.2F$; range -40F to 220F.
- b. Sensing element shall have a minimum of 1 foot of sensor length for each 2 square feet of duct or coil area. Sensor shall be arranged evenly across the duct or coil such that no point in the duct or coil is more than 1 foot away from the sensor.
- c. Probe type thermistors are acceptable in VAV box duct applications downstream of reheat coils.

3. Water Temperature Sensor:

- a. RTD type. 1000 ohm platinum RTD; accuracy: minimum $\pm 0.65F$; range -40F to 220F.

- b. Thermowell: RTD must be installed within a 316 stainless steel thermowell using a non-hardening heat conducting paste. Thermowell shall be rated for a minimum static pressure of 500 psig at the maximum operating temperature and be capable of withstanding water velocities of up to 27 fps. The sensor shall be mounted so that it extends into the flow stream to a minimum of 1/3 of the diameter of the pipe. For pipes greater than 10 inch diameter, thermowell shall be installed in a position 45 degrees from the bottom of the pipe. Separate thermometers, as specified elsewhere, shall be installed within 2 feet of each temperature sensor.

C. Humidity Measuring Devices:

1. Humidity Sensors:

- a. Room Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be minimum of 2.0% RH accuracy from 0-90% RH and 2.5% RH accuracy from 90-100% RH humidity at temperatures from 50F to 104F.
- b. Room Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be $\pm 2\%$ of reading.
- c. Duct Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be $\pm 2\%$ of reading.

2. Humidistats:

- a. Room Humidistats: Wall-mounted, proportioning type, with adjustable 2% RH throttling range, operating range from 30% to 80% at temperatures up to 100F, cover with concealed setpoint. Accuracy shall be minimum of 1.5% RH accuracy from 0-90% RH and 2.5% RH accuracy from 90-100% RH at temperatures from 50F to 104F.
- b. High Limit Duct Humidistat: 2-position insertion type, with differential maximum 2% RH.

3. Combination Room Temperature/Humidity Sensors:

- a. Wall-mounted two-piece construction, plastic enclosure, off-white color with temperature and humidity measurement, exposed single setpoint adjustment and occupant override. Large display with temperature and %RH readout display, occupied/unoccupied override button with LED, and membrane keypad and gasketing for wipe-down cleaning.
- b. Temperature Component: Thermistor sensing element or resistance temperature device (RTD), 45F to 90F operating range, $\pm 0.50F$ accuracy.
- c. Humidity Component: Proportioning type, with adjustable 2% RH throttling range, operating range from 0% to 90% at temperatures up to 110F. Accuracy shall be minimum of 2.0% RH accuracy from 0-90% RH.

4. Combination Duct Temperature/Humidity Throttle Sensors.
 - a. Duct mounted: Multi-function humidity device. Duct humidity limiter with integral temperature sensor. Proportionately reduce its output signal to the humidification equipment as duct relative humidity (RH) approaches user-defined setpoint. Initial setpoint shall be 85%RH (ADJ.). Single-pole, single-throw normally open relay contact for on/off and alarm indication. 0-10VDC or 0-20mA AC
 - b. Temperature Component: Thermistor sensing element or resistance temperature device (RTD), 1,000 ohm at 0F, 32F to 120F operating range, $\pm 0.50F$ accuracy.
 - c. Humidity Component: Polymer element, Proportioning type, with adjustable 2% RH throttling range, setpoint 60% to 95% at temperatures up to 150F. Accuracy shall be minimum of 2.0% RH accuracy from 0-90% RH.
- D. Enthalpy Sensors: Duct-mounted enthalpy sensor shall include solid state temperature and humidity sensors with electronics that shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.
- E. Pressure Measuring Devices
 1. Differential Pressure Switches:
 - a. Standard Pressure Switches:
 - 1) Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.
 - 2) Accuracy shall be $\pm 3\%$ of full scale maximum throughout entire range at 70F.
 - 3) Provide mounting brackets, probes, and shutoff valves required for proper installation.
 - 4) The range and service shall be as required for application or as noted on the drawings.
 - 5) Provide two (2) photo-transistor-activated circuits and two (2) DPDT relays for both high or low limit alarms or controls.
 - 6) Provide latching relays that require manual reset once activated.
 - 7) Acceptable Manufacturer: Dwyer Photohelic Series 3000.
 2. Pressure Transmitters/Transducer:
 - a. Air-to-Air:
 - 1) Provide transducer having the following minimum performance for measuring duct static pressure for VFD control or measuring differential pressure across filter banks:
 - a) Accuracy: $\pm 1.0\%$ FS

- b) Non-Linearity, BFS: $\pm 0.96\%$ FS
 - c) Hysteresis: 0.10% full scale
 - d) Non-Repeatability: 0.05% full scale
 - e) Thermal Effects (compensated range): 0F to +150F
 - f) Maximum Line Pressure: 10 PSI
 - g) Zero/Span Shift: 0.033% FS/F
 - h) Long Term Stability: 0.5% FS/1year
- 2) Provide transducer with the following minimum performance for measuring differential pressure across piezometer fan inlet airflow measuring stations:
 - a) Unit shall come factory equipped with static tube attached.
 - b) Unit shall include: (1) LCD shall display differential pressure on face of sensor enclosure over the entire operational range, and (2) IPCC-rated polycarbonate enclosure with short circuit proof outputs and reverse polarity protected inputs.
 - c) Accuracy at 72F: $\pm 0.25\%$ FS
 - d) Stability: $\pm 0.25\%$ full scale per year
 - e) Temperature Error: (1) Zero: $\pm 0.025\%$ full scale per C, (2) Span: Maximum $\pm 0.03\%$ full scale per C
 - f) Environmental Operating Range: 32F to 140F.
 - g) Overpressure: Proof: (1) 2 psi, (2) Burst: 3 psi
 - h) Humidity: 0% to 95% RH non-condensing.
- 3. Room Pressure Monitor System:
 - a. General:
 - 1) The room pressure monitor system shall include a room pressure monitor, remote pressure sensor, door switch, keyed switch, and low voltage control transformer.
 - 2) The system shall continuously measure, display, and monitor the room pressure.
 - 3) All components of the room pressure monitor system shall be completely designed, tested, cataloged, and coordinated for single point responsibility.
 - 4) TCC shall furnish and install all wiring as required to connect system components.
 - b. Room Pressure Monitor:
 - 1) Shall measure and display room pressure and provide access to menu driven programming options via a keypad. Refer to drawings for room pressure monitor requirements.
 - 2) A minimum of two indicator lights shall be provided on the front of the monitor to indicate ALARM and NORMAL conditions.
 - 3) There shall be an alphanumeric digital display indicating the measured room pressure in inches of H₂O with a display accuracy of 0.001 and shall be updated every second.

- 4) There shall be low and high pressure audible alarms. Each alarm shall have a unique setpoint.
- 5) The room pressure monitor shall not be capable of changing the room mode without the use of a password or keyed switch.
- 6) The room pressure monitor shall accept an input from the door switch to silence the alarm.
- 7) The room pressure monitor shall accept an input from the FMCS system to change the room mode as indicated in the control sequences.
- 8) Provide the following inputs/outputs to the FMCS system:
 - a) Pressure (analog).
 - b) Room Mode (binary).
 - c) Alarm (binary).

c. Pressure Sensor:

- 1) Shall be temperature compensated over a range of 55F to 95F.
- 2) The assembly shall not compromise the fire rating of the wall.
- 3) Shall measure room pressure from -0.20000 to +0.20000 inches H₂O with an accuracy of ± 0.001 inches H₂O.
- 4) Shall be bidirectional to determine the proper direction of pressure. Unidirectional sensors are not acceptable.
- 5) Manufacturer shall provide cable between the pressure sensor and room pressure monitor.

d. Door Switch:

- 1) Magnetic door switch designed to interface with room pressure monitor.

e. Transformer:

- 1) The transformer shall have a primary-side voltage of 120 VAC and a secondary-side voltage of 24 VAC.
- 2) The transformer shall be UL and CSA listed.
- 3) Manufacturer shall provide cable between the transformer and room pressure monitor.

f. Keyed Switch:

- 1) Two-position rotating cam-type with key removable in both positions. Rated for 20A at 120V UL listed. Back and side wired. Provide key and stainless steel coverplate in a single gang electrical rough-in box. Provide black laminated three-layer phenolic nameplate with engraved white, 1/4" minimum letters for labels.
- 2) Provide with spare keys.

4. Room Pressure Indicator:

a. General:

- 1) The room pressure monitor system shall include a room pressure monitor, pressure sensor, and low voltage control transformer.
- 2) The system shall continuously measure, display, and monitor the room pressure.
- 3) All components of the room pressure indicator shall be completely designed, tested, cataloged, and coordinated for single point responsibility.
- 4) Display shall be visual color indicator with pressure readout.
- 5) TCC shall furnish and install all wiring as required to connect system components.

b. Room Pressure Monitor:

- 1) Shall measure and display room pressure. Refer to drawings for room pressure monitor locations.
- 2) A minimum of two indicator colors shall be provided on the front of the monitor to indicate ALARM (red) and NORMAL (green) conditions.
- 3) There shall be an alphanumeric digital display indicating the measured room pressure in inches of H₂O with a display accuracy of 0.001 and shall be updated every second.
- 4) Provide the following inputs/outputs to the FMCS system:
 - a) Pressure (analog).

c. Pressure Sensor:

- 1) Shall be temperature compensated over a range of 55F to 95F.
- 2) The assembly shall not compromise the fire rating of the wall.
- 3) Shall measure room pressure from -0.20000 to +0.20000 inches H₂O with an accuracy of ± 0.001 inches H₂O.
- 4) Shall be bidirectional to determine the proper direction of pressure. Unidirectional sensors are not acceptable.
- 5) Manufacturer shall provide cable between the pressure sensor and room pressure monitor.

d. Transformer:

- 1) The transformer shall have a primary-side voltage of 120 VAC and a secondary-side voltage of 24 VAC.
- 2) The transformer shall be UL and CSA listed.
- 3) Manufacturer shall provide cable between the transformer and room pressure monitor.

F. Flow Measuring Devices:

1. Airflow Measuring Stations:

- a. Duct Mounted Airflow Measuring Stations (AFMS) - Thermal Dispersion:
- 1) Provide airflow/temperature measurement devices where indicated on the plans.
 - 2) Each AFMS shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.
 - a) Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
 - b) Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.
 - c) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
 - d) Devices using less than two thermistors in each sensor assembly are not acceptable.
 - e) Devices using platinum wire RTDs are not acceptable.
 - f) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
 - g) Pitot tubes and arrays are not acceptable.
 - h) Vortex shedding devices are not acceptable.
 - 3) All Sensor Probes:
 - a) Each sensor assembly shall independently determine the velocity and temperature at its measurement point.
 - b) Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
 - c) Airflow measuring station assembly accuracy shall be $\pm 2\%$ of Reading over the entire operating airflow range. Temperature accuracy shall be $\pm 0.15^\circ\text{F}$ between -20°F and 160°F .
 - d) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).
 - e) Each sensor probe shall have an integral, UL listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.
 - f) The number of probes shall be as recommended by the manufacturer to achieve the specified accuracy.
 - 4) Duct and Plenum Probes:
 - a) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
 - b) Probe assembly mounting brackets shall be constructed of 304 stainless steel.

- c) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

5) Sensor Density:

Area (sq.ft.)	Total # of Sensors Required
Less than 2	4
2 to less than 4	6
4 to less than 8	8
8 to less than 16	12
≥ 16	16

6) Transmitters:

- a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.
- b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.
- c) The operating temperature range for the transmitter shall be -20F to 120F.
- d) The transmitter shall be capable of communicating with other devices using one of the following interface options:
- e) Option 1: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)
- f) Option 2: RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
- g) Option 3: 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows-based PC.
- h) Option 4: LonWorks Free Topology

b. Fan Inlet Airflow Measuring Stations (AFMS) - Thermal Dispersion:

- 1) Sensor assemblies shall be mounted on 304 stainless steel housings.
- 2) Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
- 3) Mounting feet shall be constructed of 304 stainless steel and securely riveted in place to prevent loosening over time due to vibration.
- 4) The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.

5) Transmitters

- a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.
- b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.
- c) The operating temperature range for the transmitter shall be - 20F to 120F.
- d) The transmitter shall be capable of communicating with other devices using one of the following interface options:
- e) Option 1: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)
- f) Option 2: RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
- g) Option 3: 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows-based PC.
- h) Option 4: LonWorks Free Topology

6) The AFMS shall be UL listed as an entire assembly.

c. Fan Inlet Airflow Measuring Stations - Differential Pressure:

- 1) Fan Inlet Measuring Station Pressure Sensors, Transmitters and Transducers:
 - a) Select for appropriate pressure range, fan type, inlet velocity, and airflow volume.
 - b) Transmitter features and minimum performance requirements shall be as follows: (1) Combined Accuracy: $\pm 0.50\%$, (2) Terminal Point Nonlinearity: $\pm 0.40\%$, (3) Hysteresis: $\pm 0.02\%$, (4) Non-repeatability: $\pm 0.05\%$, (5) Compensation Range - Zero Shift: $\pm 0.025\%$ FS/F Span Shift: 0.025% FS/F, (6) Differential Overpressure: 5 psi proof and 25 psi burst pressure, (7) Output signal: 0 to 10 VDC.
 - c) Each transducer shall be provided with an integral manual zeroing valve to allow for field calibration of the zero-reference value without the need for shutting the operating system down.
 - d) System airflow (measured in CFM) shall be continuously displayed on an LCD display meter (0.5 inches high by 3.5 digits) located on the face of the air volume/velocity transducer control enclosure.

- d. Mounting of fan inlet static pressure sensing elements shall be in accordance with manufacturer's published installation instructions to ensure accuracy of readings.

G. Current Measuring Devices:

1. Current Switches for Constant Speed Motors:

- a. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.

2. Current Switches for Motors Controlled by VFD:

- a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor undercurrent conditions on variable or constant volume loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, induced power from the monitored load with NO output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

H. Occupancy Sensors:

- 1. Use auxiliary contacts on sensor provided and installed by the Electrical Contractor. Refer to electrical drawings for sensor location and specifications. Coordinate with Electrical Contractor.
- 2. Ceiling mounted, dual technology: sonic and passive infrared, 360-degree coverage pattern, zero crossing circuitry, adjustable sensitivity and time delay (initial setting: Time delay - 5 minutes unless noted otherwise below, integral isolated relay with normally open and normally closed outputs, LED indicator, five-year warranty, UL listed. TCC shall submit manufacturer supplied sensor layout drawing for shop drawing review. Provide full room coverage as recommended by manufacturer.
- 3. Space Occupancy Initial Setting Schedule
- 4. Initial Time
- 5. Space Delay Setting
- 6. Healthcare Procedure Room (Operating Room) 30 minutes

I. Miscellaneous Devices:

- 1. Application Specific Controller Power Supply:
 - a. For use with terminal air boxfan coil unit.

- b. Provide multiple enclosures with the following accessories and components as required to provide 24VAC power to terminal air boxes, differential pressure monitors, damper actuators, valve actuators, and other components and devices as required.
 - c. NEMA-1 steel enclosures (12"x12"x6") with separate high and low voltage compartments and separate access covers.
 - d. Either one 300 VA power supply with three 100 VA Class 2 outputs, or one 500 VA power supply with five 100 VA Class 2 outputs.
 - e. Primary side shall receive 480/277/240/120 input to 24 VAC ungrounded, isolated output on the secondary side.
 - f. Each secondary output shall include a 4 amp breaker, on/off switch, and LED indicator. Terminal blocks shall accept 16-22 AWG wire.
 - g. Acceptable Manufacturer:
 - 1) RIB Functional Devices Model MSH300A-LVC or PSH500A-LVC
2. Control Relays:
- a. Form "C" contacts rated for the application with "push-to-test" contact transfer feature and an integral LED to indicate coil energization.
 - b. Mount all relays and power supplies in a NEMA 1 enclosure beside the FMCS panel or controlled device and clearly label their functions.
3. Thermostat and Sensor Enclosures:
- a. Clear plastic guard with lock. Wire guard with tamperproof screws. Setpoint shall be adjustable with cover in place. Fasten to wall separately from thermostat. Provide guards in all corridors, gymnasiums, locker rooms, toilet rooms, assembly halls and as noted on the drawings.
 - b. Heavy Duty Enclosure:
 - 1) Perforated steel, tamperproof locking thermostat and control device enclosure.
 - 2) Box shall be nominally 8"x6"x2" deep or sized as required to fit devices to be enclosed.
 - 3) Perforated cover shall be 16 gauge steel with maximum 3/16" perforations on maximum 1/4" staggered centers for a 55% free area.
 - 4) Secure to wall from inside of box. Cover shall be secured by tamperproof screws to frame.
 - 5) Color shall match electrical devices. Verify color with the Electrical Contractor.
4. Drain Pan Condensate Overflow Switch: Float with integral magnet overflow switch conforming to UL508. No standby power required.

2.23 CONDUIT AND BOXES

- A. Conduit and Boxes: Refer to Electrical Section 260533 for materials, sizing, and other requirements

B. Conduit and Box Identification (Color and Labeling):

1. Refer to the Temperature Control Contractor notes located on the temperature controls cover sheet for raceway and box color requirements.
2. Refer to Electrical Section 260553 for raceway and box labeling requirements.

2.24 WIRE AND CABLE

A. Wire and Cable: Refer to Electrical Section 260513 for wire and cable materials.

1. Wire and Cable Color: Refer to the Temperature Control Contractor notes located on the temperature controls cover sheet for wire and cable color requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.
- B. Install system and materials in accordance with manufacturer's instructions.
- C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.
- D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.
- E. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed ADA mounting requirements.
- F. Provide valves over 3/4" size with position indicators and pilot positioners where sequenced with other controls.
- G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.
- H. After completion of installation, test and adjust control equipment.
- I. Check calibration of instruments. Recalibrate or replace.
- J. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section.

- K. All controls associated with the proper operation of air handling units, pumps, or other mechanical equipment served by emergency power shall be connected to the emergency power system. Control components shall be powered from the equipment branch. In no instance shall panel be connected to the life safety or critical branch of the emergency power system. Panels may be connected to a common 20 amp, 120 volt circuit provided the total load on the circuit does not exceed 16 amps. Circuit conductors shall be sized per the table below. All power connections to the control panels shall be performed by a licensed electrician at the cost of this Contractor. Submit circuit information (total amperage on circuit, conductors length, and panel) for control panels to the Architect/Engineer for approval.

Circuit Load (Amps)	Circuit Max Length	Feeder Size
≤ 5	≤ 200ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 10	≤ 100ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 16	≤ 75ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 200	≤ 325ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 100	≤ 160ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 75	≤ 100ft	2#10 & 1#10 ground in 3/4" conduit.

- L. All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.
- M. Remodeling:
1. All room devices as indicated on the drawings shall be removed by this Contractor. The Contractor shall also prepare the wall for finishes. Preparing the wall shall include patching old anchor holes (after the anchoring device has been removed) and sanding the wall to remove old paint outlines remaining from original devices. The wall shall be painted to match the existing wall prior to the installation of the new room device. If wall covering requires patching, the Contractor shall furnish new wall covering to match existing. If new wall covering is not available to match existing, the Contractor shall furnish a white acrylic or Plexiglas plate, 1/4" thick and sized to cover the void.
- N. Labels For Control Devices:
1. Provide labels indicating service of all control devices in panels and other locations.
 2. Labels may be made with permanent marking pen in the control panels if clearly legible.
 3. Use engraved labels for items outside panel such as outside air thermostats.
 4. Labels are not required for room thermostats, damper actuators and other items where their function is obvious.

O. VFDs:

1. This project includes several variable frequency drives to control the flow of fans and/or pumps based on a control variable.
2. Verify output signal required, 4-20 mA or 0-10V dc, with the EC.
3. If VFD has a bypass feature, auxiliary contacts on the drive may not be used for motor status. A separate relay must be used to indicate motor rotation in either hand or auto positions.
4. If a separate current transmitter or switch is indicated for status, install this device between the VFD and the motor. In this case, the drive status may be connected to the auxiliary contacts in the VFD.
5. Some devices, such as low limits and fire alarm shutdown relays, must be hardwired to the fan motor. Make connections such that fan will shut down whether in hand or auto position if the unit has a bypass feature.

P. Airflow Stations:

1. The transmitter shall be installed at a location that is protected from weather, water, and vibration.
2. Mount transmitter where they can easily be read (36" to 66" above floor). Do not fasten transmitters directly to ductwork or compromise duct insulation.
3. The manufacturer's authorized representative shall visit the project site during construction prior to station installations to confirm all submitted sizes, mounting requirements and locations. Size adjustments shall be made at no additional cost. The representative shall meet on site with the TCC to support and train them on proper installation procedures and calibration.
4. Install labels at each sensor and transmitter identifying its service.

3.2 GRAPHIC DISPLAY

- A. Create a customized graphic for each piece of equipment indicated on the itemized points list.
- B. Components shall be arranged on graphic as installed in the field.
- C. Include each graphic point listed in the itemized points list using real time data.
- D. Provide a graphic representation of the following:
 1. Where there are multiple buildings, color code the campus map by the systems serving that building. The building graphic shall be linked to the graphic for that building's systems.
 2. Where there are multiple floors, provide color codes/designations for the areas served by each AHU and TAB by floor.
 3. Where multiple AHUs serve one floor, color code the areas served by each AHU. The area shall be linked to the graphic for that area's AHU.
 4. Provide an overall floor plan of each floor of the building color coded by zone linked to the TAB for that zone. The zone shall be linked to the graphic for that zone's TAB graphic.
 5. Show the location of each thermostat on the floor plan.

6. Provide separate graphics showing the chilled and heating water system flow diagram. Show temperatures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
 7. Provide a graphic showing the steam system flow diagram. Show pressures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
- E. The FMCS shall include full graphic operator interface to display the following graphics as a minimum:
1. Home page to include a minimum of six critical points: Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW, etc.
 2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
 3. Detailed graphics for each mechanical system including AHUs, ERUs, EFs, chillers, and boilers, as a minimum.
 4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.
- F. The FMCS shall include individual graphical buttons to access the following data stored in PDF format:
1. Project control as-built documentation including all TCS drawings, diagrams and sequences of operation.
 2. TCS Bill of Material for each system, e.g. AHU, RTU, FCU, boiler, etc.
 3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.

3.3 CONDUIT AND BOXES INSTALLATION

- A. Conduit and Box Installation: Refer to Electrical Section 260533 for execution and installation.
- B. Conduit and Box Identification (color and labeling) installation. Refer to Electrical Section 260553 for raceway and box identification installation.
- C. Outlet Box Schedule: Thermostat/temperature sensor:
1. Dry Interior Locations: Provide 4" square galvanized steel with raised cover to fit flush with finished wall line. When located in concrete block walls, provide square edge title cover of sufficient depth to extend out to face of block or masonry boxes.
 2. Other Conditions: Refer to Electrical Section 260533 for requirements.

3.4 WIRE AND CABLE INSTALLATION

- A. Wire and Cable Installation: Refer to Electrical Section 260513 for execution and installation.

B. Field Quality Control:

1. Inspect wire and cable for physical damage and proper connection.
2. Torque test conductor connections and terminations to manufacturer's recommended values.
3. Perform continuity test on all conductors.
4. Protection of cable from foreign materials:
 - a. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
 - b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

C. Installation Schedule:

1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquidtight flexible metallic conduit. Terminations in hazardous areas, as defined in the National Electrical Code, shall be made with flexible conduit rated for the environment.

3.5 FMCS INSTALLATION

- A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.
- B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

3.6 COMMISSIONING

- A. Upon completion of the installation, this Contractor shall load all system software and start up the system. This Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.
- B. This Contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the FMCS system operation.
- C. This Contractor shall prove that the controls network is functioning correctly and within acceptable bandwidth criteria and shall test the system with an approved protocol analysis tool. Provide a log and statistics summary showing that each channel is within acceptable parameters. Each channel shall be shown to have at least 25% spare capacity for future expansion.
- D. Upon completion of the performance tests described above, repeat these tests, point by point, as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.
- E. System Acceptance: Satisfactory completion is when this Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.7 PREPARATION FOR BALANCING

- A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).
- B. Check the calibration and setpoints of all controllers.
- C. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.
- D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at TAB reheat terminals until the unit is at the minimum CFM.
- E. Verify the operation of all interlock systems.

3.8 TEST AND BALANCE COORDINATION

- A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

- B. The Contractor shall provide a minimum of four (4) hours training for the Balancing Contractor in the use of these tools.
- C. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process until the first 20 terminal units are balanced.
- D. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.

3.9 DEMONSTRATION AND ACCEPTANCE

- A. At completion of installation, provide two days minimum instruction for operators. Demonstrate operation of all controls and systems. Describe the normal operation of all equipment.

3.10 TRAINING

- A. On-Site:
 - 1. One month after completion of commissioning, the manufacturer shall provide 16 hours of training on consecutive days for 2 Owner's representatives. The training course shall enable the Owner's representatives to perform Advanced Operations and System Management as defined herein. A factory-trained instructor with experience in presenting the training material and the system programmer for this project shall perform the training.
- B. Day-to-Day Operations - Training Description:
 - 1. Proficiently operate the system.
 - 2. Understand control system architecture and configuration.
 - 3. Understand FMCS systems components.
 - 4. Understand system operation, including FMCS system control and optimizing routines (algorithms).
 - 5. Operate the workstation and peripherals.
 - 6. Log-on and off the system.
 - 7. Access graphics, point reports, and logs.
 - 8. Adjust and change system setpoints, time schedules, and holiday schedules.
 - 9. Recognize malfunctions of the system by observation of the printed copy and graphic visual signals.
 - 10. Understand system drawings and Operation and Maintenance manual.
 - 11. Understand the job layout and location of control components.
 - 12. Access data from FMCS controllers and ASCs.
 - 13. Operate portable operator's terminals.
- C. Advanced Operations - Training Description:
 - 1. Make and change graphics on the workstation.
 - 2. Create, delete, and modify alarms, including annunciation and routing of these.
 - 3. Create, delete and modify point trend logs and graph or print these both on and ad-hoc basis and at user-definable time intervals.
 - 4. Create, delete, and modify reports.

5. Add, remove, and modify system's physical points.
6. Create, modify and delete programming.
7. Add panels when required.
8. Add operator interface stations.
9. Create, delete, and modify system displays, both graphic and others.
10. Perform FMCS system field checkout procedures.
11. Perform FMCS controller unit operation and maintenance procedures.
12. Perform workstation and peripheral operation and maintenance procedures.
13. Perform FMCS system diagnostic procedures.
14. Configure hardware including PC boards, switches, communication, and I/O points.
15. Maintain, calibrate, troubleshoot, diagnose, and repair hardware.
16. Adjust, calibrate, and replace system components.

D. System Management - Training Description:

1. Maintain software and prepare backups.
2. Interface with job-specific, third-party operator software.
3. Add new users and understand password security procedures.

E. Provide course outline and materials in accordance with the "SUBMITTALS" article in Part 1 of this section. The instructor(s) shall provide one copy of training material per student.

3.11 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Averaging sensors and low limits shall be installed at the top of the assembly with the element on a slight downward incline away from the sensor making a serpentine pattern over the cross-sectional area with elements spaced not over 12" apart and within 6" of the top and bottom of the area.
- F. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- G. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Architect/Engineer. TCC shall prime and paint the device enclosure. Color selection by Architect.
- H. Install all wall-mounted CO2 sensors between 3 feet and 6 feet above the floor.

3.12 INSTALLATION OF FLOW METERS

- A. Provide manufacturer's recommended lengths of straight piping upstream and downstream of the flow meter. Up to 30 diameters upstream of the flow meter may be required depending on the piping arrangement and flow meter type.
- B. Maintain adequate pull/service space.

END OF SECTION

SECTION 230913 - INSTRUMENTATION

1.1 SECTION INCLUDES

- A. POSITIVE DISPLACEMENT METERS.
- B. PRESSURE GAUGE.
- C. PRESSURE GAUGE ACCESSORIES.
- D. THERMOMETERS.
- E. TEST PLUGS.
- F. STATIC AND DIFFERENTIAL AIRFLOW PRESSURE GAUGES.

1.2 SUBMITTALS

- A. SUBMIT SHOP DRAWINGS PER SECTION 230500. INCLUDE LIST THAT INDICATES USE, OPERATING RANGE, TOTAL RANGE AND LOCATION FOR MANUFACTURED COMPONENTS.

1.3 PRESSURE GAUGES

- A. GAUGES SHALL BE 4-1/2" DIAMETER WITH ALUMINUM OR STAINLESS STEEL CASE WITH PHOSPHOR BRONZE BOURDON TUBE, BRASS SOCKET FOR AIR, STEAM, WATER OR OIL APPLICATION, 1/2" BOTTOM CONNECTION. GAUGES SHALL BE 1% FULL SCALE ACCURATE WITH BRONZE BUSHED BRASS MOVEMENT AND ADJUSTABLE POINTER. STANDARD RANGES TO BE EITHER PRESSURE OR PRESSURE AND VACUUM AS REQUIRED OF APPLICATION.
- B. MANUFACTURERS:
 - 1. ASHCROFT
 - 2. MARSH
 - 3. MARSHALLTOWN
 - 4. MILJOCO
 - 5. TRERICE
 - 6. U.S. GAUGE FIGURE 1901
 - 7. WEKSLER
 - 8. WIKA.
- C. GAUGES SHALL BE 4-1/2" DIAMETER WITH PHENOLIC TURRET STYLE, GLYCERIN FILLED, SAFETY CASE WITH PHOSPHOR BRONZE OR 316 STAINLESS STEEL BOURDON TUBE, BRASS SOCKET FOR AIR, STEAM, WATER OR OIL APPLICATIONS. GAUGES SHALL BE 1/2% FULL SCALE ACCURATE PER ANSI B40.1 WITH BRUSHED STAINLESS STEEL MOVEMENT AND HAIR SPRING GUARD. STANDARD RANGES TO BE EITHER PRESSURE OR PRESSURE AND VACUUM AS REQUIRED OF APPLICATION.

D. MANUFACTURER:

1. ASHCROFT
2. MARSHALLTOWN
3. MARSH
4. MILJOCO
5. TRERICE
6. U.S. GAUGE FIGURE 1980
7. WEKSLER
8. WIKA.

E. SELECT GAUGE RANGE FOR NORMAL READING NEAR CENTER OF GAUGE.

1.4 PRESSURE GAUGE ACCESSORIES

- A. ALL PRESSURE GAUGES SHALL HAVE VALVES AND PRESSURE SNUBBERS. ALL PRESSURE GAUGES ON STEAM SHALL HAVE PIGTAIL SYPHON.
- B. SHUTOFF VALVE: 1/2" BALL VALVE AS SPECIFIED FOR EACH PIPING SYSTEM.
- C. PRESSURE SNUBBER, BRASS WITH 1/2" CONNECTIONS, POROUS METAL TYPE.
- D. ALL PRESSURE GAUGE PIPING SHALL BE MINIMUM 1/2" 304 STAINLESS STEEL PIPE OR COPPER TUBE.

1.5 THERMOMETERS

A. DIAL TYPE:

1. 4-1/2" DIAMETER, HERMETICALLY SEALED CASE. STAINLESS STEEL CASE AND STEM. ACCURACY OF 1% FULL SCALE WITH EXTERNAL RECALIBRATOR.
2. SELECT THERMOMETERS FOR APPROPRIATE TEMPERATURE RANGE. ADJUSTABLE ELBOW JOINT WITH LOCKING DEVICE TO ALLOW ROTATION OF THERMOMETER TO ANY ANGLE.
3. STEM LENGTHS AS REQUIRED FOR APPLICATION WITH MINIMUM INSERTION OF 2-1/2".
4. THERMOMETERS FOR WATER, STEAM, OR OIL SHALL HAVE BRASS OR STEEL SEPARABLE SOCKET. THERMOMETER WELLS SHALL BE STAINLESS STEEL, PRESSURE RATED TO MATCH PIPING SYSTEM DESIGN PRESSURE; WITH 2 INCH EXTENSION FOR INSULATED PIPING AND THREADED CAP NUT WITH CHAIN PERMANENTLY FASTENED TO WELL AND CAP. THERMOMETERS FOR AIR SHALL HAVE AN ALUMINUM OR BRASS DUCT FLANGE.
5. MANUFACTURER:
 - A. ASHCROFT
 - B. MARSH
 - C. MARSHALLTOWN
 - D. MILJOCO

- E. TEL-TRU
- F. TRERICE
- G. U.S. GAUGE
- H. WEKSLER, WIKA.

B. ALCOHOL/SPIRIT FILLED TYPE:

1. 9" LONG PHENOLIC CASE, STEEL STEM, ACCURACY OF 1% FULL SCALE. ADJUSTABLE ELBOW JOINT WITH 180-DEGREE ADJUSTMENT IN VERTICAL PLANE, 360-DEGREE ADJUSTMENT IN HORIZONTAL PLANE, AND LOCKING DEVICE TO ALLOW ROTATION OF THERMOMETER TO ANY ANGLE.
2. SELECT THERMOMETER FOR APPROPRIATE TEMPERATURE RANGE.
3. STEM: COPPER PLATED STEEL, ALUMINUM, OR BRASS FOR SEPARABLE SOCKET. STEM LENGTHS AS REQUIRED FOR APPLICATION WITH MINIMUM INSERTION OF 3".
4. THERMOMETERS FOR WATER, STEAM, OR OIL SHALL HAVE BRASS OR STEEL SEPARABLE SOCKET. THERMOMETER WELLS SHALL BE STAINLESS STEEL, PRESSURE RATED TO MATCH PIPING SYSTEM DESIGN PRESSURE; WITH 2 INCH EXTENSION FOR INSULATED PIPING AND THREADED CAP NUT WITH CHAIN PERMANENTLY FASTENED TO WELL AND CAP. THERMOMETERS FOR AIR SHALL HAVE AN ALUMINUM OR BRASS DUCT FLANGE.
5. MANUFACTURER:

- A. MARSH
- B. MILJOCO
- C. TRERICE
- D. WEKSLER
- E. WIKA.

C. DIGITAL TYPE:

1. 1/2" LCD DIGITAL DISPLAY, SOLAR POWERED, WITH HIGH IMPACT ABS CASE. ACCURACY OF 1% OF READING OR 1F, WHICHEVER IS GREATER. ADJUSTABLE ELBOW JOINT WITH LOCKING DEVICE TO ALLOW ROTATION OF THERMOMETER TO ANY ANGLE.
2. FAHRENHEIT/CELSIUS SWITCHABLE WITH -50/300F RANGE.
3. THROUGH-CASE POTENTIOMETER RECALIBRATION ADJUSTMENT.
4. STEM LENGTHS AS REQUIRED FOR APPLICATION, WITH MINIMUM INSERTION OF 2-1/2".
5. THERMOMETERS FOR WATER, STEAM, OR OIL SHALL HAVE BRASS OR STEEL SEPARABLE SOCKET. THERMOMETER WELLS SHALL BE STAINLESS STEEL, PRESSURE RATED TO MATCH PIPING SYSTEM DESIGN PRESSURE; WITH 2 INCH EXTENSION FOR INSULATED PIPING AND THREADED CAP NUT WITH CHAIN PERMANENTLY FASTENED TO WELL AND CAP. THERMOMETERS FOR AIR SHALL HAVE AN ALUMINUM OR BRASS DUCT FLANGE.

6. DIGITAL DISPLAY SHALL OPERATE AT 10 LUX (ONE FOOT-CANDLE) OR MORE. USE THIS THERMOMETER ONLY WHERE AMBIENT TEMPERATURES ARE BELOW 140F AND THERE IS SUFFICIENT LIGHT UNDER NORMAL OCCUPIED SPACE CONDITIONS FOR THE DIGITAL DISPLAY TO FUNCTION. USE A DIFFERENT TYPE THERMOMETER WHERE THERE IS INADEQUATE LIGHT AVAILABLE (I.E., DARK MECHANICAL ROOMS, LOCATIONS WHERE THE THERMOMETER IS SHIELDED FROM LIGHT, ETC.).
7. MANUFACTURER:
 - A. MILJOCO
 - B. TRERICE
 - C. WEKSLER
 - D. WIKA.

D. SELECT SCALES TO COVER EXPECTED RANGE OF TEMPERATURES.

1.6 TEST PLUGS

- A. TEST PLUG: 1/4" OR 1/2" BRASS FITTING AND CAP, WITH NORDEL CORE FOR TEMPERATURES UP TO 275F, FOR RECEIVING 1/8" OUTSIDE DIAMETER PRESSURE OR TEMPERATURE PROBE. PLUGS SHALL BE RATED FOR ZERO LEAKAGE FROM VACUUM TO 500 PSI.
- B. PROVIDE EXTENDED UNITS FOR ALL PLUGS INSTALLED IN INSULATED PIPING.
- C. TEST KIT: CARRYING CASE, INTERNALLY PADDED AND FITTED CONTAINING ONE 3-1/2" DIAMETER PRESSURE GAUGE WITH 0-100 PSI RANGE, ONE GAUGE ADAPTER WITH 1/8" PROBES, TWO 1-1/2" DIAL THERMOMETERS WITH 0F TO 220 AND -25F TO 125F RANGES AND 5" STEMS.

1. MANUFACTURERS:

- A. SISCO
- B. FLOW DESIGN
- C. PETERSON EQUIPMENT
- D. MG PIPING PRODUCTS CO.
- E. MILJOCO, TRERICE
- F. WATTS REGULATOR.

1.7 STATIC AND DIFFERENTIAL AIRFLOW PRESSURE GAUGES

- A. DIAPHRAGM-ACTIVATED GAUGE WITH 4-3/4" DIAL, CAST ALUMINUM CASE, SEALED INTERIOR, DESIGNED TO RESIST SHOCK AND VIBRATION, AND RATED FOR 15 PSIG.
- B. ACCURACY SHALL BE $\pm 3\%$ OF FULL SCALE MAXIMUM THROUGHOUT ENTIRE RANGE AT 70F.
- C. PROVIDE MOUNTING BRACKETS, PROBES, AND SHUTOFF VALVES REQUIRED FOR PROPER INSTALLATION.

D. THE RANGE AND SERVICE SHALL BE AS REQUIRED FOR APPLICATION OR AS NOTED ON THE DRAWINGS.

E. MANUFACTURERS:

1. DWYER MAGNEHELIC SERIES 2000
2. MARSHALLTOWN INSTRUMENT SERIES 85C.

1.8 INSTALLATION

A. GENERAL INSTALLATION REQUIREMENTS:

1. INSTALL PER MANUFACTURER'S INSTRUCTIONS.
2. COIL AND CONCEAL EXCESS CAPILLARY ON REMOTE ELEMENT INSTRUMENTS.
3. INSTALL GAUGES AND THERMOMETERS IN LOCATIONS WHERE THEY ARE EASILY READ FROM NORMAL OPERATING LEVEL.
4. DO NOT INSTALL INSTRUMENTATION WHEN AREAS ARE UNDER CONSTRUCTION, EXCEPT FOR REQUIRED ROUGH-IN, TAPS, SUPPORTS AND TEST PLUGS.

B. POSITIVE DISPLACEMENT METERS:

1. INSTALL POSITIVE DISPLACEMENT METERS WITH SHUTOFF VALVES ON INLET AND OUTLET. PROVIDE FULL LINE SIZE VALVED BYPASS WITH GLOBE VALVE FOR LIQUID SERVICE METERS.

C. PRESSURE GAUGES:

1. CONNECT PRESSURE GAUGES TO SUCTION AND DISCHARGE SIDE OF ALL PUMPS.
2. PROVIDE 1/2" TUBING FOR PRESSURE GAUGE AND GAUGE ACCESSORIES.
3. PROVIDE SNUBBER FOR EACH PRESSURE GAUGE.
4. PROVIDE COIL SYPHON FOR EACH PRESSURE GAUGE CONNECTED TO STEAM PIPING.
5. INSTALL GAUGES WITH BOTTOM THREADED CONNECTIONS AT 6 O'CLOCK POSITION.

D. THERMOMETERS:

1. INSTALL THERMOMETERS IN PIPING SYSTEMS IN SOCKETS IN SHORT COUPLINGS. ENLARGE PIPES SMALLER THAN 2-1/2" FOR INSTALLATION OF THERMOMETER SOCKETS.
2. INSTALL THERMOMETER SOCKETS ADJACENT TO CONTROL SYSTEM THERMOSTAT, TRANSMITTER AND SENSOR SOCKETS.
3. LOCATE DUCT THERMOMETERS MINIMUM 10 FEET DOWNSTREAM OF MIXING DAMPERS, COILS, OR OTHER DEVICES CAUSING AIR TURBULENCE.

END OF SECTION

SECTION 230920 - VENTURI VALVE AIRFLOW CONTROL SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Venturi Airflow Control Valve
- B. Controllers, Components
- C. Interface to FMCS

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this section, with minimum five years' experience.
- B. The airflow system provider shall be an entity that designs, develops, manufactures, and sells products and services to control the environment and airflow of critical spaces using a Quality Management System registered to ISO 9001:2008.
- C. Open loop venturi air valves that use damper position to represent flow must be calibrated on NVLAP accredited air stations.
- D. Closed loop venturi air valves that measure airflow and control to setpoint must be $\pm 5\%$ accurate over a 10:1 turndown. Third-party testing must be provided upon request.

1.3 SUBMITTALS

- A. Submit shop drawings per Sections 23 05 00 and 23 09 00. In addition, submit an electronic copy of the shop drawings in .pdf format to the Owner for review.
- B. Refer to Section 230900 for additional information.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling Requirements:
 - 1. Prior to installation, the control system components shall be stored in dry conditions within an environment complying with the product specifications as shown on product data sheets within the submittals.
 - 2. The system products shall be handled and transported in a manner consistent with trade practices for control systems and instruments.

1.5 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the work of this section with that of other sections to ensure that the work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the contract documents for possible conflicts between the work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

1.6 WARRANTY

- A. Warranty shall commence upon the date of shipment and extend for a period of 60 months for all airflow control devices and 36 months for all other control system components.
- B. Refer to Section 230500 for warranty requirements.
- C. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation, or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.
- D. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.
- E. Update all software and backups during the warranty period and all user documentation on the Owner's archived software disks.

1.7 Pre-Installation Meetings

- A. The critical environment control system representative shall review the proper installation of the system with the Sheet Metal Contractor and the BAS Contractor.
- B. Project Installation Phase: The representative shall make periodic visits to the project job site to ensure that the system is being installed properly to assure optimal performance and that the location and orientation of the control valves is consistent for proper operation and future Owner maintenance. Any discrepancies shall first be brought to the attention of the appropriate subcontractor. If no action is taken by said subcontractor, the representative shall bring these issues to the Project Manager, Architect/Engineer, or Owner's Representative for resolution.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Phoenix Controls
- B. Critical Room Control (CRC)
- C. Price Industries, Inc.

D. Johnson Controls Critical Environments

E. TSI

2.2 AIRFLOW CONTROL SYSTEMS

A. A critical environment control system shall be furnished and installed to control the airflow into and out of laboratories and/or other areas as noted on the plans. The exhaust flow rate of a fume hood shall be controlled precisely to maintain a constant average face velocity into the fume hood at either a standard/in-use or standby level based on an operator's presence in front of the fume hood. The control system shall vary the amount of makeup/supply air into the room to operate the room at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain pressurization in relation to adjacent spaces (positive or negative). The critical environment control system shall be capable of operating as a standalone system or as a system integrated with the Facility Management and Control System (FMCS). An optional locally mounted user interface terminal shall be available to allow room-level control variables to be displayed, and where appropriate, edited to adjust control operation.

2.3 COMPONENTS

A. Usage Based Control Equipment:

1. For variable air volume (VAV) systems, a sash sensor shall be provided to measure the height of each vertically moving fume hood sash. A sash sensor shall also be provided to measure the opening of horizontal overlapping sashes. Control systems employing sidewall-mounted or through-the-wall (TTW) velocity sensors to control the fume hood exhaust airflow shall utilize dual air path with chip thermistor technology that can be demonstrated to meet sash response that meets ANSI Z95 performance guidelines. Hot wire anemometer sidewall sensors, or sensors that do not meet speed of response, are not acceptable.
2. A presence sensor (PS) shall be provided to determine an operator's presence in front of a hood by detecting the presence and/or motion of an operator, and to command the system from an in-use operating face velocity (e.g., 100 FPM) to a standby face velocity (e.g., 60 fpm) and vice versa.
 - a. The sensor shall define an adjustable detection zone that extends approximately 20 inches from the front of the fume hood. If the sensor does not detect presence and/or motion in its detection zone within an adjustable time period, it shall command the system to the user-adjustable standby face velocity. When the sensor detects the presence and/or motion of an operator within the detection zone, it shall command the system to the in-use face velocity within 1.0 second.
 - b. The sensor shall sense an inanimate object when placed in the detection zone and remain in the standard mode of operation for an adjustable time period, after which it will return to a standby mode. Operators shall enter and leave the zone with the unit adjusting automatically between in-use and standby modes. If the inanimate object is moved or taken out of the zone, the unit shall adapt to the change automatically.

- c. The sensor shall have an adjustable detection zone capable of covering a fume hood up to 8 feet wide and be mounted from 6 to 12 feet above the floor surface.
 - d. The sensor shall be configurable for varying levels of lighting intensity and motion sensitivity.
 - e. The sensor shall have the ability to operate on either AC or DC power sources.
 - f. Wide area motion detectors (on the hood or at the room level) shall be unacceptable.
3. The airflow at the fume hood shall vary in a linear manner between two adjustable minimum and maximum flow setpoints to maintain a constant face velocity throughout this range. A minimum volume flow shall be set to ensure flow through the fume hood even with the sash fully closed.

B. Airflow Control Device/ Venturi Valve - General:

1. The valve assembly manufacturer's airflow control device shall be registered to ISO 9001.
2. An open loop airflow control device shall be mechanically pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change (within product specifications) or quantity of airflow controllers on a manifolded system.
3. A closed loop airflow control device shall measure airflow and control to a setpoint. Closed loop air valve shall be $\pm 5\%$ accurate over a 10:1 turndown.
4. The airflow control device shall maintain accuracy within $\pm 5\%$ of signal to setpoint.
5. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.
6. No rotational/axial orientation requirements shall be required to ensure accuracy and/or pressure independence.
7. The airflow control device shall maintain pressure independence regardless of loss of power. "Electronically pressure independent" devices are not acceptable.
8. Valve manufacturer will provide minimum required differential pressure in writing for each size valve they offer.
9. Devices that require duct static pressure to be increased to achieve maximum flow shall not be acceptable.

10. The airflow control device shall be constructed of:

- a. The airflow control device for non-corrosive airstreams, such as supply and general exhaust, shall be constructed of minimum 16 gauge aluminum. The device's shaft and internal "S" link shall be made of 316 stainless steel. The shaft support brackets shall be made of galvanized (non-shutoff valves) or 316 stainless steel (shutoff valves). The pivot arm shall be made of aluminum (for non-shutoff valves) and 303/304 stainless (for shutoff valves). The pressure independent springs shall be a spring-grade stainless steel. All shaft bearing surfaces shall be made of a PP (polypropylene), PPS (polyphenylene sulfide) composite, or Teflon. Sound attenuating devices used in conjunction with general exhaust or supply airflow control devices shall be constructed using 24 gauge galvanized steel or other suitable material used in standard duct construction. No sound absorptive materials of any kind shall be used. Silencers shall be absorptive type with polymer-lined acoustic media.
 - b. The airflow control device for corrosive airstreams, such as fume hoods and biosafety cabinets, shall have a baked-on, corrosion-resistant phenolic coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal "S" link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring-grade stainless steel. The internal nuts, bolts, and rivets shall be stainless steel. All shaft bearing surfaces shall be made of PP (polypropylene), PPS (polyphenylene sulfide) composite, or Teflon.
 - c. The airflow control device for highly corrosive airstreams shall be as described directly above. In addition, they shall have no exposed aluminum or stainless steel components. Shaft support brackets, pivot arm, and pressure independent springs shall have a baked-on, corrosion-resistant phenolic coating in addition to the materials defined directly above. The internal "S" link, nuts, bolts, and rivets shall be epoxy phenolic coated stainless steel. Only devices clearly defined as "high corrosion resistant" on project drawings will require this construction.
 - d. The airflow control device for extremely corrosive airstreams, such as acid digestion fume hoods, shall have a PVDF (polyvinylidene fluoride fluoropolymer) coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel with PVDF coating. The pivot arm and internal mounting link shall be made of 316 or 303 stainless steel with PVDF coating. The pressure independent springs shall be a spring-grade stainless steel with Teflon (PTFE) coating. The internal nuts, bolts, and rivets shall be stainless steel with PVDF coating. All shaft bearing surfaces shall be made of Teflon or PPS (polyphenylene sulfide) composite. Only devices clearly defined as "extremely corrosion resistant" on project drawings will require this construction.
- 1) Note: Airflow control devices utilizing vortex shedding sensors and installed in fume hoods or corrosive environments MUST be constructed with stainless steel bodies and MUST have stainless steel vortex shedding sensors. Polycarbonate vortex shedding sensors are NOT acceptable in corrosive environments.

11. Actuation:
 - a. For high speed electrically actuated VAV operation, a CE certified, UL listed, IP56 rated for dust and water, electronic actuator shall be factory mounted to the valve. Loss of main power shall cause the valve to position itself in an appropriate failsafe state. Options for these failsafe states include normally open-maximum position, normally closed-minimum position, and fail-to-last position. This position shall be maintained constantly without external influence, regardless of external conditions on the valve (within product specifications). During normal operation, the high speed actuated airflow control device shall initiate valve movement and achieve the commanded airflow value with no more than 5% overshoot or undershoot within 1 second or less.
 - b. For standard speed electrically actuated VAV operation, a CSA certified, UL recognized (IP54 rating and CE certification optional on single valves, standard on dual valves) electronic actuator shall be factory mounted to the valve. The failsafe state for standard speed operation valves shall be fail to last position unless otherwise noted.
 - c. During normal operation, the standard speed actuated airflow control device shall initiate valve movement and achieve the commanded airflow value with no more than 5% overshoot or undershoot within 60 seconds (90 seconds for a shutoff valve from shutoff to maximum flow or vice versa).
 - 1) Standard speed actuation should not be used for valves that are connected to VAV fume hoods.
 - 2) Standard speed actuation can be used on 2-state fume hoods or vented cabinets or snorkels with on/off conditions.
12. The room-level airflow control devices shall function as a standalone network.
13. There shall be no reliance on external or building-level control devices to perform room-level control functions. Each control system shall have the capability of performing fume hood control, pressurization control, standard and advanced temperature control, humidity control, and implement occupancy and emergency mode control schemes.
14. The critical environment control system shall have the option of digital integration with the FMCS.
15. NVLAP Accreditation (Lab Code 200992-0) (if applicable):
 - a. Each airflow control device shall be factory characterized on air stations NVLAP Accredited (a program administered by NIST) to ISO/IEC 17025:2005 standards.
 - b. Each airflow control device shall be factory characterized to the job specific airflows as detailed on the plans and specifications using NVLAP Accredited air stations and instrumentation having a combined accuracy of no more than $\pm 1\%$ of signal (5,000 to 250cfm), $\pm 2\%$ of signal (249 to 100cfm) and $\pm 3\%$ of signal (199 to 35cfm). Electronic airflow control devices shall be further characterized and their accuracy verified to $\pm 5\%$ of signal at a minimum of 48 different airflows across the full operating range of the device.

- c. Each airflow control device shall be marked with device-specific factory characterization data. At a minimum, it should include the room number, tag number, serial number, model number, eight-point characterization information (for electronic devices), date of manufacture, and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation. Characterization data shall be stored indefinitely by the manufacturer and backed up off site for catastrophic event recovery.

C. Exhaust and Supply Airflow Device Controller:

1. The airflow control device shall be a microprocessor-based design and shall use closed loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.
2. During normal operation, the airflow control device shall initiate valve movement and achieve the commanded airflow value with no more than 5% overshoot or undershoot within:
 - a. 1 second or less with high speed actuation.
 - b. 60 seconds for standard speed actuation (90 seconds from shutoff to max flow and vice versa).
3. The airflow control device shall store its control algorithms in non-volatile, rewriteable memory. The device shall be able to be standalone or to be networked with other room-level digital airflow control devices using an industry standard protocol.
4. Room-level control functions shall be embedded in and carried out by the airflow device controller using distributed control architecture. Critical control functions shall be implemented locally; no separate room-level controller shall be required.
5. The airflow control device shall use industry standard 24 VAC power.
6. The airflow control device shall have provisions to connect a commissioning tool, and every node on the network shall be accessible from any point in the system.
7. The airflow control device shall have built-in integral input/output connections that address fume hood control, temperature control, humidity control occupancy control, emergency control, and non-network sensors switches and control devices. At a minimum, the airflow controller shall have:
 - a. Three universal inputs capable of accepting 0 to 10 VAC, 4 to 20 mA, 0 to 65 K ohms, or Type 2 or Type 3 10 K ohm at 77F thermistor temperature sensors.
 - b. One digital input capable of accepting a dry contact or logic level signal input.
 - c. Two analog outputs capable of developing either a 0 to 10 VAC @ 1 mA (10Kohm min) or 4 to 20 mA (500 ohm max) linear control signal.
 - d. One Form C (SPDT) relay output capable of driving up to 1 A @ 24 VAC/VAC.
8. The airflow control device shall meet FCC Part 15 Subpart J Class A, CE, and CSA Listed per file #228219.
9. The airflow control device shall be ROHS compliant.

D. Airflow Control Device/Venturi Valve - Leakage:

1. Two types of shutoff airflow devices shall be available: standard shutoff (no gasket) and low leakage shutoff (with gasket).
2. The shutoff airflow control device shall have shutoff leakage and casing leakage of no greater than the following (with 5.0" wc static pressure):

Shut-off Valve Type and Airflow Range	Shut-off Leakage	Casing Leakage
Standard shutoff devices up to 1600 CFM/472 L/s	6 CFM	0.060 CFM
Low leakage shutoff devices up to 850 CFM	0.005 CFM	
Low leakage shutoff devices up to 1,300 CFM	0.010 CFM	

3. Manufacturer shall provide comprehensive leakage charts generated from ASME N510 pressure decay testing. Standard shutoff devices shall be tested up to and including 5" wc static pressure. Low-leakage shutoff devices shall be tested up to and including 30" wc static pressure.

E. Two-Position Exhaust Airflow Control Device/Venturi Valve:

1. The airflow control device shall provide functionality for constant volume, two position, or fully modulating. Two-position devices requiring feedback shall generate a 0 to 10 volt feedback signal that is linearly proportional to its airflow. All two-position devices shall be either networked or hard-wired into the room-level network to be considered under pressurization control.

F. Local Display Unit:

1. The control system shall have an optional local display option that allows monitoring and control of system variables to be displayed on a user interface terminal device.
2. The display unit shall have the ability to connect to the room level devices through a room integrator or BACnet compatible room monitor.
3. The display unit shall be powered by 24 VAC.
4. The local display unit shall have the provisions of being flush mounted or surface mounted directly to a standard electrical enclosure. Electrical conductors shall terminate inside the display module housing to a pluggable terminal block.
5. The enclosure shall be made from material that is resistant to chemicals that are typically used in the lab for wipe down and general cleaning agents.
6. The unit's exposed surfaces shall be chemically resistant to vaporized hydrogen peroxide (VHP), formaldehyde, chloride dioxide (clidox), perchloric acid, sodium hypochloride/hypochlorite 3-6% (bleach), and quaternary ammonium 7% in 1:128 tap water (ammonia).
7. The display unit shall be rated for use in areas where IP54 rating is required.
8. The display unit shall utilize a 7" diagonal touchscreen display with optional color schemes to adapt the display to various lighting conditions.
9. The display unit shall provide a means of entering and displaying a unique location descriptor (device ID).

10. The display unit shall allow access to pertinent flow, temperature, humidity, pressure data, occupancy and emergency mode control status, and current device or system alarm status. Data shall be viewable in units of measure appropriate for users of the system.
11. The display unit shall have the ability to display:
 - a. Present value, which may be read directly off the network or conditioned with a fixed multiplier and/or offset to scale the value for the desired units of measure.
 - b. Units of measure, which are configurable based on local user conventions.
12. Setpoints and editable control parameters shall be viewable on the view. The user shall have the ability to provide four levels of access. There shall be three levels of PIN code access to prevent unauthorized changes to setpoints and editable control parameters.
13. Monitor shall have the ability to locally display alarms for:
 - a. Numeric high and low limits
 - b. Binary inputs (alarm selectable for True or False state)
 - c. Multistate alarms (alarmable on all but one state)
14. Alarms shall have adjustable volume and the ability to be muted for situations where a visual alarm is acceptable or an audible alarm is not desired.

G. Fume Hood Display:

1. The display screen shall be a color LCD resistive touch screen (240 x 320 RGB).
2. The touch screen shall support input configurations for fume hood operational parameters done at the touch panel and, at a minimum, include:
 - a. Sash dimensions
 - b. Hood ID
 - c. Hood certification reminder
 - d. Hood occupancy status
 - e. Stopwatch/TIMER
 - f. Message display
3. Hood configuration for the following properties shall be viewable and editable from the touch display:
 - a. Sash dimensions
 - b. Hood ID
 - c. Hood certification reminder
 - d. Hood occupancy status
 - e. Stopwatch/timer
 - f. Message display
4. The enclosure shall be made from material that is resistant to chemicals that are typically used in the lab for wipe down with non-solvent cleaning agents.

5. The unit's exposed surfaces shall be chemically resistant to vaporized hydrogen peroxide (VHP), formaldehyde, chloride dioxide (clidox), perchloric acid, sodium hypochloride/hypochlorite 3-6% (bleach), and quaternary ammonium 7% in 1:128 tap water (ammonia).
6. Two mechanical membrane buttons shall be provided at the front panel of the display to enable users to quickly activate emergency exhaust mode and mute without having to remove protective gloves.
7. Flush mount or recess mount shall be installation options.
8. A USB port shall be provided to support firmware and software upgrades and shall be covered to protect against moisture or corrosion.
9. A timer feature shall be provided to enable users to set specific durations for experiments and provide visual and audible alarms when the set time is expired.
10. The fume hood display shall have an available I/O at its associated valve controller that may be used to receive a 0 - 10 volt signal from a through-the-wall (TTW) sensor. The TTW shall not control the valve but provide a drift alert to indicate when the TTW sensor reading is out of range relative to the sash position face velocity value.
11. Power: The device shall be powered by 24 VAC $\pm$ 15% at 10VA, 50/60 Hz.
12. Configuration:
 - a. Configuration shall be performed from the touch display and/or manufacturer's software tools.
 - b. The device shall be capable of being added to an existing LON communication network.
 - c. The device shall display fume hood performance data based on control logics embedded inside the valve controller.
13. Communication:
 - a. The fume hood display unit shall be capable of communicating with the building FMCS via BACnet or LON.
 - b. The device shall display fume hood performance data based on sash movements and valve controller performance.
14. Information Display:
 - a. The device shall have the ability to indicate when the fume hood face velocity is within the normal operating range as well as energy saving, hood certification, hood ID, timer, and hood occupancy status.
 - b. The device shall be configurable to display one of the following measurement units: cubic feet per minute (CFM), meters cubed per hour (m^3/h), liters per second (l/s), feet per minute (fpm), or meters per second (m/s).
 - c. The device shall have the ability to display system errors caused by the airflow valve or sash travel.
 - d. The device shall have the ability to indicate to users when the hood is due for recertification by stating on the LCD display "Hood Cert. Due MM/DD/YYYY".

15. Emergency (Purge) Exhaust:

- a. The display shall have a mechanical membrane button on the lower portion that, when pressed, will initiate an emergency (purge) exhaust mode in the attached fume hood valve(s).
 - 1) Button shall be mechanical so that users with rubber, nitrile, vinyl, latex, or other gloves can operate the emergency exhaust button.
- b. The emergency (purge) exhaust mode, when initiated, will send the attached fume hood exhaust valve(s) to either the maximum flow of the valve or another predefined flow (as configured in the fume hood valve).

16. Alarms:

- a. The device shall have the ability to show alarms on the main screen using visual and audible alerts.
- b. The main screen background color shall change to flashing red with text stating the type of alarm.
- c. In alarm state, the visual indication shall remain active until the event that triggered the alarm is removed or fixed.
- d. The audible alarm tone shall be cleared only when the event that triggered the alarm is removed or fixed.
- e. The device shall have an alarm muting option that silences the audible alarm for an adjustable time period when the mute button is pushed. If another alarm is generated during the mute period, the new alarm shall override the mute delay and the alarm shall sound again.
- f. The device shall have the ability to customize audible alarms levels and customize mute duration.
- g. Users shall have the ability to change the volume of the alarm tone to low, medium, or high.
- h. The device shall have the ability to show diversity alarm.
 - 1) Diversity alarm shall be generated by the valve or from the FMCS system.
 - 2) No audible tone for diversity alarm shall be generated at the fume hood display.

17. Energy Conservation:

- a. The device shall have the ability to enable fume hood hibernation mode.
 - 1) When activated, with the sash fully closed and no chemicals present in the hood, the exhaust flow through the fume hood goes to the minimum allowed by the exhaust valve (or shutoff where available).
 - 2) The mode shall be initiated by a sequence including entering the menu and a password on the touch display, an external momentary switch input to the fume hood controller, or a network command via FMCS or BAS.

- 3) When activated, the LCD display shall show "Hood in Hibernation" and the exhaust valve shall move to its minimum position or shutoff position.
 - 4) Safety shall be built into the hibernation mode whereby opening the fume hood sash shall automatically return the fume hood exhaust to an in-use operating volume as determined by the sash sensor. Fume hood hibernation shall be a point that can be integrated to the FMCS.
 - b. The device shall provide nighttime energy waste alarming to generate a visual and audible alarm to indicate that the fume hood sash is open beyond its minimum flow position and the lights in the room are off.
 - 1) When activated, the LCD display shall show "Energy Waste Close Sash" and the audible alarm shall sound until the sash is closed.
 - 2) The light levels at which the alarm is both initiated and cancelled shall be configurable.
 - c. The device shall provide sash energy waste alarming that generates a visual and audible alert to notify when the fume hood sash is open beyond a configurable set position and no one is in front of the fume hood.
 - 1) When activated, the LCD display shall show "Energy Waste Close Sash" and remain until the sash is closed.
18. Security: End users shall have the ability to enable a PIN pass code to prevent unauthorized changes to sash heights, airflow settings, and other editable parameters.
19. Compliance:
 - a. The unit shall be certified as meeting regulatory compliance with CE, CUL, and rohs.
 - b. The unit shall be suitable for use with non-solvent wipe down and is designed to meet IP44 test standards.
 - c. The device shall comply with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
 - 1) This device shall not cause harmful interference.
 - 2) This device shall accept any interference received, including interference that may cause undesired operation.
20. Environment:
 - a. The operating temperature range shall be between 32F and 122F.

2.4 PERFORMANCE/DESIGN CRITERIA

- A. Each dedicated critical environment control system shall support a minimum of 20 network controlled airflow devices.

- B. The system shall employ individual average face velocity controllers that directly measure the area of the fume hood sash opening and proportionally control the hood's exhaust airflow to maintain a constant face velocity over a minimum range of 20% to 100% of sash travel. The corresponding minimum hood exhaust flow turndown ratio shall be 5 to 1.
- C. The hood exhaust airflow control device shall respond to the fume hood sash opening by achieving 90% of its commanded value within one second of the sash reaching 90% of its final position (with no more than 5% overshoot/undershoot) of required airflow. Rate of sash movement shall be from 1 to 1-1/2 feet per second.
- D. The hood exhaust airflow control device shall be switched automatically between in-use and standby levels based on the operator's presence immediately in front of the hood. A presence and motion sensor shall activate the switching. The airflow control device shall achieve the required in-use commanded value in less than one second from the moment of detection with no more than a 5% overshoot or undershoot.
- E. The system shall maintain specific airflow ($\pm 5\%$ of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change, airflow change or quantity of airflow control devices on the manifold (within 0.3" to 3.0" wc).
- F. The system shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions, such as the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure. Systems using differential pressure measurement, vortex shedding measurement, or velocity measurement to control room pressurization are unacceptable.
- G. The system shall maintain specific airflow ($\pm 5\%$ of signal) with a minimum turndown as specified in Components, Airflow Control Device/ Venturi Valve - General above to ensure accurate pressurization at low airflow and guarantee the maximum system diversity and energy efficiency.
- H. Airflow Control Sound Specification:
 - 1. The critical environment control system manufacturer shall provide comprehensive sound power level data for each size airflow control device. All data shall be obtained from testing in accordance with ASHRAE/ANSI Standard 130, Methods of Testing Air Terminal Units.
 - 2. All proposed airflow control devices shall include discharge, exhaust, and radiated sound power level performance.
 - 3. If the airflow control device cannot meet the sound power levels required to achieve the sound criteria appropriate for the space, as determined by the Architect/Engineer, a properly sized sound attenuator must be used. All sound attenuators must be of a packless design (constructed of at least 18 gauge 316L stainless steel when used with fume hood exhaust) with a maximum pressure drop at the device's maximum rated flow rate not to exceed 0.20"wc.

2.5 OPERATION SEQUENCES

- A. The airflow control devices shall utilize distributed control architecture to perform room-level control functions. Control functions shall include, at a minimum, volumetric offset pressurization, temperature, humidity control, as well as respond to hood flow demands, occupancy, and emergency control commands.
- B. Volumetric Offset Pressurization Control:
 - 1. The control system shall control supply and auxiliary exhaust airflow devices to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure (within specified range for medium or low pressure valves). This offset shall be field adjustable and represents the volume of air that will enter (or exit) the room from the corridor or adjacent spaces.
 - 2. The pressurization control algorithm shall sum the flow values of all supply and exhaust airflow devices and command appropriate controlled devices to new setpoints to maintain the desired offset. The offset shall be adjustable as a configurable parameter in the critical environment control system as set by startup technician or FMCS /BAS.
- C. Occupancy Control:
 - 1. The control system shall have the ability to change the minimum ventilation and/or temperature control setpoints, based on the occupied state, in order to reduce energy consumption when the space is not occupied. The occupancy state may be set by either the FMCS as a scheduled event or through the use of a local occupancy sensor or switch. The control system shall support a local occupancy override button that allows a user to override the occupancy mode and set the space to occupied for a predetermined interval. The override interval shall be configurable from one to 1440 minutes. The local occupancy sensor/switch or bypass button shall be given priority over an FMCS command.
- D. Emergency Mode Control:
 - 1. The control system shall provide a means of overriding temperature and pressurization control in response to a command indicating an emergency condition exists, and airflow control devices are to be driven to a specific flow setpoint. The system shall support up to four emergency control modes (zone or valve level). The emergency control modes may be initiated either by a local contact input or FMCS command. Valve level emergency modes can be individually programmed on each valve as one of four emergency control modes. Zone level emergency modes shall drive supply and exhaust valves to maintain or ignore zone offset (excludes control of hood valves).
 - 2. Once an emergency mode is invoked, pressurization and temperature control are overridden for the period that the mode is active. Emergency modes shall have a priority scheme allowing a more critical mode to override a previously set condition.

E. Local Alarm Control:

1. The control system shall provide the means of summing selective alarm activity at the room-level network and generating a local alarm signal. The local alarm signal may be directed to any available output as well as to the FMCS. The alarm mask may be configured differently for each room-level system.

F. Shutoff Control:

1. The control systems shall provide means of commanding airflow devices to shutoff sequence in one of four modes.
 - a. Emergency Mode Control: The shutoff sequence can be initiated locally through a universal input or remotely from the FMCS or other controller such as the local display unit (LDU) using emergency mode(s). Fume hood airflow devices cannot be controlled locally using a universal input (refer to mode 2 below).
 - b. Hibernation Mode Control: The shutoff sequence can be initiated on a fume hood airflow device using hibernation mode in conjunction with an FHM631 fume hood monitor or a Sentry fume hood display in one of three methods: local contact closure, pushbutton sequence using faceplate of fume hood monitor, or remotely via FMCS. If the sash on the fume hood is moved when hood is in hibernation mode, hood will automatically return to normal operation with no interaction to the fume hood monitor or fume hood display. Hibernation or decommission modes that require the occupant to enter the fume hood monitor or fume hood display menu or settings to return to normal control mode are unacceptable.
 - c. Auto Gex Shutoff Mode Control: The shutoff sequence can be initiated on a general exhaust (Gex) airflow device in a lab environment when the total non-Gex exhaust airflow satisfies minimum air change rate and cooling demand for a period greater than 60 seconds. Shutoff must be enabled on the general exhaust airflow device.
 - d. IAQ Mode Control: The shutoff sequence can be initiated when exhaust airflow is distributed between a general exhaust and return airflow device. If shutoff is enabled, the general exhaust airflow device will shut when return ratio is 100% and the return airflow device will shut when the return ratio is 0%.

G. Diversity Alarm:

1. The control system shall have the ability to monitor the airflow values for the pressurized space and generate an alarm signal in the event the total exhaust flow exceeds a predetermined threshold. The diversity alarm is intended to allow the user to take diversity in the design and generate an alarm condition in the event the diversity threshold is compromised. This function must be available in either an integrated or standalone system.

H. The critical environment control system shall provide control for all valves required per the plans and specs.

- I. All points shall be available through the interface to the FMCS for trending, archiving, graphics, alarm notification, and status reports. Critical environment control system performance (speed, stability and accuracy) shall be unaffected by the number of points being monitored, processed, or controlled.
- J. All devices/controllers shall be native BACnet or LON.
- K. Refer to the FMCS specification for the required input/output summary for the necessary points to be monitored and/or controlled.

2.6 INTERFACE TO FACILITY MANAGEMENT AND CONTROL SYSTEMS

- A. The critical environment control system network shall have the capability of digitally interfacing with the FMCS. The required software interface drivers shall be developed and housed in one or more dedicated interface devices furnished by the supplier. Open protocol native BACnet is preferred. For providers who cannot offer native BACnet, a detailed submittal or BACnet integration requirements shall be provided with submittal data.
- B. All room-level points shall be available to the FMCS for monitoring or trending. The critical environment control system integrator and/or room manager shall maintain a cache of all points to be monitored by the FMCS. The room-level airflow control devices shall continually update this cache.
- C. Room Level Integration:
 - 1. Device shall be non-proprietary. No special tools shall be required to make the system available.
 - 2. If the room level integration device drops off the network or loses power, it shall not cause the zone balance, temperature control, or fume hood devices to lose control. The room level valve devices should operate independently of the room level integration device. Space controller, room controller with hardwired control of hood, general exhaust and supply valves, or PLC with hardwired control of fume hood, general exhaust or supply valves for zone balance, temperature control, room offset, etc. are not acceptable.
 - 3. Room level controller shall be able to integrate to FMCS through BACnet/IP, BACnet/Ethernet, BACnet MS/TP, or LON through onboard communication adapters and shall be field configurable/upgradable.
- D. Room Manager:
 - 1. Critical environment integration shall support distributed network architecture from room level BACnet MS/TP segment or LON FTT-10 bus to a dedicated BACnet MS/TP segment, building BACnet/Ethernet, or BACnet/IP building backbone using single or multiple IP addresses. Backbone communication protocol must be field selectable/upgradable.
 - 2. Devices in a room or zone will operate independent of building level communications, maintaining integrity of the airflow. Critical environment control system building level communication, or loss of, will not disrupt the communication between devices in a room or zone.

3. Critical environment control system integration shall provide an easy means to access room level device health status at a room-by-room or building-wide level.
4. Critical environment control system integration shall provide an easy means to access test and balance functions at a room-by-room basis. Test and balance functions should include:
 - a. Setting the devices in the room to various conditions in order to read airflow.
 - b. Manually override the outputs for testing purposes.
 - c. Adjust airflow to meet field acceptance tests.
5. Critical environment control system integration must work with the FMCS for long-term trending.
6. Critical environment control system integration shall provide optional software to manage local backup and restore, entire site device management, building-wide test and balance functions, building-wide diagnostic tools, and building-wide configuration tools. Software shall be field upgradable to support graphical dashboard displays.

2.7 ACTIVE PRESSURE CONTROL SYSTEMS

- A. Each pressurized space that requires active pressure control shall have a dedicated airflow space pressurization control system to control the airflow in and out of the space to maintain the desired pressurization level, either positive or negative. The space pressure control system shall function as an interactive control system consisting of variable volume flow control devices, all of which shall be under control with flow feedback into the zone pressure control function. The space pressure control system shall vary the amount of makeup/supply or exhaust/return air into or out of the room to operate the space at the lowest possible airflow rates necessary, to maintain temperature control, achieve minimum ventilation rates, and maintain space pressurization in relation to adjacent spaces (positive or negative). The space pressurization airflow control system shall operate as a standalone system with the ability to operate with the building management system (FMCS). An optional locally mounted user interface terminal shall be available to allow room-level control variables to be displayed, and, where appropriate, edited to adjust control operation.
- B. Pressure Control:
 1. The space pressure control shall maintain a minimum ventilation flow rate to obtain the desired air changes per hour. Two minimum ventilation flow setpoints shall be provided: one for occupied periods and one for unoccupied periods; which setpoint is used shall be a function of the occupancy control state. The minimum ventilation setpoints shall be configurable as either fixed values or writable from the FMCS.

2. The pressure control function shall maintain a fixed flow for either the supply or exhaust side devices under control and modulate the controlled exhaust or supply side devices in order to maintain space pressurization. The space pressure control system shall provide for a base fixed volumetric offset setpoint to ensure directional airflow, even if the pressure control function is not running. The pressure control variable shall be configurable to have either or both a filtered control signal and/or a controlled ramp time to dampen the control signal, if required.

C. Performance:

1. Each airflow control device shall maintain specific airflow ($\pm 5\%$ of signal within one second of a change in duct static pressure), regardless of the magnitude of the pressure change, airflow change, or quantity of airflow control devices on the manifold (within 0.3" to 3.0" wc).
2. After proper commissioning, the space pressurization control system shall maintain space pressurization capable of controlling to ± 0.01 " wc of the desired setpoint.
3. The airflow control system shall maintain specific airflow ($\pm 5\%$ of signal) with a minimum 8 to 1 turndown to ensure accurate pressurization at low airflow and guarantee the maximum system diversity and energy efficiency.
4. Provide all controller electronics within finished steel enclosures mounted on the air valves or wall-mounted enclosures if shown on plans.

2.8 ADVANCED PRESSURE MONITOR (SENSOR, TRANSMITTER, DISPLAY)

A. Provide pressure-to-current transmitters with the following minimum specifications:

1. Color, touch-screen display
2. Resistant to spray washdown (rated for use in IP54 environments)
3. Multi-function input signal of 0-10VAC, 0-5VAC or 4-20 mA
4. Standard accuracy RSS of at least $\pm 0.5\%$ full scale (non-linearity, hysteresis, and non-repeatability)
5. Optional high accuracy RSS of at least $\pm 0.25\%$ full scale (non-linearity, hysteresis, and non-repeatability)
6. Integral zero and span adjustment
7. Temperature effect on zero/span shift $\pm 0.03\%$ FS/F
8. Pressure ranges, selected by Architect/Engineer, shall be up to (-1.0" to +1.0"wc)
9. Temperature range: 32F to 120F
10. Programmable visual alarm and adjustable audible alarm
11. Alarm contact output, SPDT, contact rating of 2.0A at 30VAC/VAC, 0.6A at 125VAC

B. Products:

1. Sensors are required as indicated on the drawings.

2.9 ROOM AIR PRESSURE SENSOR PLATE

- A. Provide shielded static air probes for sensing room pressure levels. Probes shall be flush mounted in a standard 2" x 4" electrical box.

- B. The pressure-sensing tubing shall be connected to the top of the probe with 1/4" tubing. Tubing shall also be extended from the pressure sensor to a stable common pressure reference port.
- C. The exact placement of the sensor plates and means of establishing a stable common reference pressure shall be determined by the Architect/Engineer.

2.10 PRESSURE

- A. Door status switches with SPDT form C contacts with the following ratings shall be provided:
 - 1. The maximum switching voltage is 30 volts at 0.1 A.
 - 2. The maximum switching current is 0.25 A at 12 V.
- B. Door switches shall be installed and mounted per the manufacturer's recommendation.
- C. Products:
 - 1. GE Sentrol Wide Gap Switch Model 1078 Series

2.11 CONTROL FUNCTIONS

- A. The airflow control devices shall include, at a minimum, pressurization, temperature, and humidity control, as well as respond to occupancy and emergency control commands.
- B. Active Pressurization Control:
 - 1. The space pressure control system shall control supply and exhaust airflow devices to maintain at a minimum ± 0.01 " wc. The pressurization control algorithm shall sum the flow values of all supply and exhaust airflow devices and command appropriately controlled devices to new setpoints to maintain the desired offset. The offset shall be adjustable.
 - 2. The pressurization control algorithm shall support the ability to regulate the distribution of total supply flow across multiple supply airflow control devices to optimize air distribution in the space.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Facility Management and Control System (FMCS) or Building Automation System (BAS) Contractor shall install the sash sensors, interface boxes, presence and motion sensor, and fume hood monitor on the fume hood under initial supervision of the supplier. Reel-type sash sensors and their stainless steel cables shall be hidden from view. Bar-type sash sensors shall be affixed to the individual sash panels, or use of fixed sash sensors with take-up reels is also permitted. Sash interface boxes with interface cards shall be mounted in an accessible location. Sidewall sensors are acceptable for use to control the fume hood valves. Hot wire thermal anemometer type side wall sensors are not acceptable. The sidewall sensor must maintain a speed of response per ANSI-Z95.
- B. The FMCS Contractor shall install all critical environment control system devices in an accessible location.
- C. The FMCS Contractor shall install an appropriately sized and fused 24 VAC transformer suitable for NEC Class II wiring.
- D. All cable shall be furnished and installed by the FMCS Contractor. The FMCS Contractor shall terminate and connect all cables as required. The FMCS Contractor shall utilize cables specifically recommended by the airflow controls supplier.
- E. The Mechanical Contractor shall install all airflow control devices in the ductwork and shall connect all airflow control valve linkages.
- F. The Mechanical Contractor shall provide and install all reheat coils, neutralizers, silencers, and transitions.
- G. The Mechanical Contractor shall provide and install insulation as required.
- H. Each pressurization zone shall have either a dedicated, single-phase primary circuit or a secondary circuit disconnect.

3.2 SYSTEM STARTUP

- A. System startup shall be provided by a factory trained and authorized representative of the critical environment control system manufacturer. Startup shall include calibrating the fume hood monitor and any combination sash sensing equipment, as required. Startup shall also provide electronic verification of airflow (fume hood exhaust, supply, makeup, general exhaust, or return), system programming and integration to FMCS (when applicable).
- B. The Balancing Contractor shall be responsible for final verification and reporting of all airflows. For all field flow measurement devices, the balancer shall produce a flow report that documents field flows vs. device flow and associated error. This shall be tabulated for each device location at several flows including min and max. Cost and responsibility to meet the specified performance shall be carried by the ACS.

3.3 CLOSEOUT ACTIVITIES

A. Training

1. The critical environment control system supplier shall furnish a minimum of eight (8) hours of Owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves, and general troubleshooting procedures.
2. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.

END OF SECTION

SECTION 232100 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings
- B. Valves
- C. Check Valves
- D. Strainers
- E. System Piping Schedule

1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.
- C. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 1. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

1.4 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 230500 for required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 STEEL PIPE (ABOVE GRADE)

- A. Design Pressure 125 psig, Maximum Design Temperature 225F (230F for grooved couplings).
- B. Black Steel; Standard Weight; Threaded Joints:
 - 1. Pipe: Standard weight black steel, threaded and coupled, ASTM A53; Type E, F, or S; Grade B.
 - 2. Joints: Screwed.
 - 3. Fittings: Class 125 cast iron, ASTM A126, ASME B16.4; or Class 150 malleable iron, ASTM A197, ASME B16.3.
 - 4. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.
- C. Black Steel; Standard Weight; Welded or Flanged Joints:
 - 1. Pipe: Standard weight black steel, beveled ends, ASTM A53, Type E or S, Grade B.
 - 2. Joints: Butt-welded or flanged.
 - 3. Fittings: Standard weight wrought steel, butt-welding type, ASTM A234, ASME B16.9.
 - 4. Flanges: Class 150 forged steel, welding neck or slip-on, ASTM A181 or A105, Class 60, ASME B16.5 up to 24" and B16.47 above 24". ASME B16.1 for flanges mating with flat face equipment flanges. Flange face seal weld (backweld) is required for slip-on flanges.
- D. Black Steel; Standard Weight; Mechanically Coupled Grooved Joints:
 - 1. Pipe: Standard weight black steel, grooved ends, ASTM A53, Type E or S, Grade B.
 - 2. Joints: Grooved type, with Grade E EPDM molded pressure-responsive gaskets suited for 32F to 230F per ASTM D2000.
 - a. Rigid Type: Housings cast with offsetting, angle-pattern, bolt pads to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9, and to prevent mis-assembly due to overshift. Housings cast with alignment indicator notch for visual proper alignment to adjoining fitting. Center-leg gasket with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth. Installation ready for direct stab installation without field disassembly. Design Basis: Victaulic 107V.
 - 1) Usage: All locations unless noted elsewhere.
 - 3. Fittings: ASTM A536 Grade 65-45-12 ductile, ASTM A234 Grade WPB wrought steel, or factory manufactured from ASTM A53 steel pipe, grooved type.
 - 4. Flanges: Grooved end, flanged adapter for direct connection to ANSI Class 150 flanged components.

- a. Flange adapters to be used for connecting grooved piping to equipment flanges only. Grooved flange adapters shall not be used to connect lug style valves to grooved piping. Design Basis: Victaulic Style 741 and W741.
5. Optional Packaged Coupling/Fittings:
 - a. At the Contractor's option, couplings/fittings for plain-end carbon steel piping may be used on applicable piping systems in sizes NPS 1/2" thru 2" (DN15 through DN50) and working pressure to 300 psi. Fittings shall consist of a ductile iron housing conforming to ASTM A536, Grade 65-45-12, with installation-ready ends, full body gasket liner, zinc-electroplated steel bolts and nuts, and 300 Series stainless steel retainer. Design Basis: Victaulic QVSD System.
- E. Black Steel; Standard Weight; Welded:
 1. Design Pressure: 125 psi. Maximum Design Temperature: 1000F.
 2. Pipe: Standard weight black steel, beveled ends, ASTM A53.
 3. Joints: Butt welded.
 4. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade WPB, ANSI B16.9.
- 2.2 COPPER PIPE (ABOVE GRADE)
 - A. Design Pressure 125 psig. Maximum Design Temperature 225F.
 - B. Copper Pipe; Type L; Soldered Joints:
 1. Tubing: Type L drawn temper seamless copper tube, ASTM B88.
 2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.
 3. Fittings: Wrought copper solder joint, ASME B16.22.
 - C. Copper Pipe; Type L; Mechanical Press Connection:
 1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.
 2. Joints: Mechanical press connection.
 3. Fittings: Copper, ASME B-16.51, with embedded EPDM O-ring, NSF-61.
 4. Fitting Identification: Press ends shall provide the ability to identify an unpressed fitting from the floor prior to testing. The function of this feature is to provide the installer quick and easy identification of connections that have not been pressed prior to putting the system into operation.
 5. Special Requirements: Mechanical press fitting manufacturer shall provide contractor training prior to installation.
 6. Manufacturers:
 - a. Viega ProPress.
 - b. Elkhart Xpress.
 - c. NIBCO Press System Fittings and Valves.
 - d. Merit Brass
 - e. Mueller Streamline PRS.

D. Copper; DWV; Soldered:

1. Tubing: DWV drawn temper seamless copper drainage tube, ASTM B306.
2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.
3. Fittings: ASME B16.23 cast brass, or ASME B16.29 solder wrought copper.

2.3 VALVES

A. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Gate Valves(Steel Pipe):
 - a. GA-1: 2" and under, 125 psi S at 353F, 300 psi WOG at 150F, screwed, bronze, rising stem, screwed bonnet.
 - 1) Manufacturers:
 - a) Crane #431
 - b) Hammond #IB641
 - c) Stockham #B122
 - d) Walworth #56
 - e) Milwaukee #1150
 - f) Watts #B-3210
 - g) NIBCO #T-131
 - h) Jomar T-351G
 - b. GA-2: 2-1/2" thru 12", 125 psi S at 353F, 200 psi WOG at 150F, flanged, iron body, bronze mounted, OS&Y.
 - 1) Manufacturers:
 - a) Crane #465-1/2
 - b) Hammond
 - c) Stockham #G623
 - d) Walworth
 - e) Milwaukee #F2885
 - f) Watts #F-503
 - g) NIBCO F-617-O.
3. Ball Valves:
 - a. BA-1 (Steel and Copper): 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals.
 - 1) Body: Bronze of a copper alloy containing less than 15% zinc.

- a) Manufacturers: Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB, Jomar T/S-200CSS.
 - 2) Body: Dezincification resistant brass alloy. Jomar T/S-100CSSG.
 - 3) Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping. (For example, Jomar modifies valve part number with -IH for insulated handle.)
 - 4) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120F, heating water piping over 120F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim. (For example, Jomar modifies valve part number with -LH for locking handle.)
- b. BA-1A (Steel): 2-1/2" and 3", 125 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals.
- 1) Manufacturers:
 - a) Apollo #88A-100
 - b) Nibco #F510-CS/66
 - c) Milwaukee #F90.
 - 2) Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.
 - 3) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120F, heating water piping over 120F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

4. Butterfly Valves:

a. BF-1:

- 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20F to 225F continuous and 250F intermittent at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze, stainless steel, or electroless-nickel coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size.
- 2) Manufacturers:
 - a) Victaulic #300
 - b) Center Line Series 200
 - c) Keystone #222
 - d) Watts #DBF-03-121-1P
 - e) Nibco N200 Series or LD2000 Series
 - f) Milwaukee CL Series
 - g) Hammond 5200 Series
 - h) Jomar 600-__DSEL Series
- 3) 8" thru 12", 175 psi CWP, elastomers for 20F to 225F at 130 psi, fully lugged end, ductile or cast iron body (not in contact with fluid), bronze, stainless steel, electroless coated ductile iron or aluminum-bronze disc, EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to the centerline of the valve body (to permit pipe extension without draining system), weatherproof gear operator.
- 4) Manufacturers:
 - a) Victaulic #3
 - b) Center Line Series 200
 - c) Keystone #222
 - d) Watts #DBF-03-121-1G
 - e) Nibco N200 Series or LD2000 Series
 - f) Milwaukee CL Series
 - g) Hammond 5200 Series
 - h) Jomar 600-__DSEG Series
- 5) Mechanically coupled grooved end valves are acceptable if they have the temperature ratings, pressure ratings, and features listed above. Valve stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.
- 6) Manufacturers:
 - a) Victaulic # Vic-300 and AGS-Vic300

2.4 THROTTLING VALVES

A. Throttling Valves (Steel):

1. For pipe systems where mechanical press connections are allowed, throttling valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Ball Valves (Steel and/or Copper):
 - a. BA-9: 2" and under, 125 psi saturated steam, 600 psi WOG, standard port, screwed (solder ends are acceptable only if rated for soldering in line with 470F melting point of lead-free solder), bronze body and ball of copper alloy containing less than 15% zinc, chrome plated or stainless steel ball, Teflon seats and seals with memory stop.
 - 1) Manufacturers:
 - a) Apollo #70-120
 - b) Stockham #S-216BR-R
 - c) Milwaukee #BA-100
 - d) Watts #B-6000
 - e) Hammond #8501
 - f) Nibco #580-70.
3. Butterfly Valves:
 - a. BF-4:
 - 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20F to 225F continuous and 250F intermittent at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze, stainless steel, or electroless-nickel coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size.
 - 2) Manufacturers:
 - a) Victaulic #300
 - b) Center Line Series 200
 - c) Keystone #222
 - d) Watts #DBF-03-121-1P
 - e) NIBCO LD2000 Series
 - f) Milwaukee CL Series
 - g) Hammond 5200 Series
 - h) Jomar 600-__DSEL Series

- 3) 8" thru 12", 175 psi CWP, elastomers for 20F to 225F at 130 psi, fully lugged end, ductile or cast iron body (not in contact with fluid), bronze, stainless steel, electroless coated ductile iron or aluminum-bronze disc, EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to the centerline of the valve body (to permit pipe extension without draining system), weatherproof gear operator.
- 4) Manufacturers:
 - a) Victaulic #300
 - b) Center Line Series 200
 - c) Keystone #222
 - d) Watts #DBF-03-121-1G
 - e) NIBCO LD2000 Series
 - f) Milwaukee CL Series
 - g) Hammond 5200 Series
 - h) Jomar 600-__DSEG Series

2.5 LOCK OUT TRIM

- A. Provide lock out trim for all quarter turn valves opening to atmosphere installed in heating water piping over 120F and as indicated on the drawings.

2.6 CHECK VALVES

- A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. CK-1: Check Valves (Steel Pipe); 2" and under, 125 psi S at 353F, 200 psi WOG at 150F, screwed, bronze, horizontal swing.

1. Manufacturers:

- a. Crane #37
- b. Hammond #IB904
- c. Walworth #3406
- d. Milwaukee #509
- e. NIBCO #T-413
- f. Jomar T-511G

- C. CK-4: Check Valves (Copper Pipe); 2" and under, 200 psi WOG at 150F, solder, bronze, horizontal swing.

1. Manufacturers:

- a. Crane #1342
- b. Hammond #IB912
- c. Walworth #406SJ
- d. Milwaukee #1509

- e. Watts #B-5001
 - f. NIBCO #S-413.
 - D. CK-8: Grooved End Check Valves: 2" thru 24", ductile iron body with stainless steel spring, suitable for vertical installation. Stainless steel disc(s) with elastomer seat/seal, or elastomer coated ductile iron disc with welded-in nickel seat.
 - 1. 2" thru 12": Rated to 300 psi;
 - a. Victaulic Series 716
 - b. Titan Flow Control Series CV31G-UL-DI
 - 2. 14" thru 24": Rated to 230 psi;
 - a. Victaulic Series W715
 - E. CK-13: Check Valves (Steel Pipe); 2-1/2" thru 12", 200# WOG, double disc wafer type, non-slam silent check, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size.
 - 1. Manufacturers:
 - a. Milliken 740G
 - b. NIBCO W-920-W
 - c. Crane Duo-Chek
 - d. Victaulic V715
 - e. Titan Flow Control CV41A-DI
 - F. CK-14: Center Guided/Axial Sliding Disk Silent Check Valve: 2" thru 24", ductile iron body with stainless steel spring, suitable for vertical installation. Stainless steel disc(s) with elastomer seat/seal, or elastomer coated ductile iron disc with welded-in nickel seat.
 - 1. Manufacturers:
 - a. Flow Tech
 - b. Titan Flow Control
 - c. Champion
 - d. Av-tek
- 2.7 STRAINERS
- A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
 - 1. Titan Flow Control YS57-NB
 - B. ST-1: Bronze body, screwed ends, screwed cover, 125 psi S at 353F, 200 psi WOG at 150F.

1. Manufacturers:

- a. Armstrong #F4SC
- b. Metraflex #TS
- c. Mueller Steam Specialty Co. #351
- d. Sarco #BT
- e. Watts #777
- f. NIBCO T-221-A
- g. Titan Flow Control YS55-BZ

C. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S at 353F, 175 psi WOG at 150F.

1. Manufacturers:

- a. Armstrong #A1FL
- b. Metraflex #TF
- c. Mueller Steam Specialty Co. #758
- d. Sarco #CI-125
- e. Watts #77F-D
- f. Victaulic #732 or #W732
- g. NIBCO F-721-A.

D. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:

1. Pipe Size:

- a. 1/4" - 2": 1/32" screen
- b. 2-1/2" - 8": 1/16" screen
- c. 10" and Up: 1/8" screen

E. Furnish pipe nipple with ball valve, threaded hose connection, and cap to blow down all strainer screens.

F. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends, remove burrs, bevel plain-end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- D. Connect to all equipment with flanges or unions. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

- E. Flush and clean piping as defined below. When system water is clear, remove, clean and replace all strainer screens (blowing down strainer without removing and cleaning screen is not acceptable).
- F. After completion, fill, clean, and treat systems. Refer to Section 232500 for treatment.

3.2 SYSTEMS, PIPING, AND VALVE SCHEDULE

A. Heating Water (Above Grade - maximum 200F unless noted otherwise below):

- 1. Black Steel; Standard Weight; Threaded Joints: 2" and Under
- 2. Black Steel; Standard Weight; Plain End Mechanical Coupled: 2" and Under
- 3. Copper Pipe; Type L; Soldered Joints: 2" and Under
- 4. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
- 5. Black Steel; Standard Weight; Welded or Flanged Joints: 2-1/2" and Over
- 6. Black Steel; Standard Weight; Grooved Joints: 2-1/2" and Over
- 7. Shutoff Valves: BA-1, BA-1A (STEEL), BF-1, BF-5
- 8. Throttling Valves: BA-9, BF-4, BF-5
- 9. Check Valves: CK-1, CK-4
- 10. Strainers: ST-1, ST-2, ST-3

B. Chilled Water (Above Grade):

- 1. Black Steel; Standard Weight; Threaded Joints: 2" and Under
- 2. Black Steel; Standard Weight; Plain End Mechanical Coupled: 2" and Under
- 3. Copper Pipe; Type L; Soldered Joints: 2" and Under
- 4. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
- 5. Black Steel; Standard Weight; Welded or Flanged Joints: 2-1/2" and Over
- 6. Black Steel; Standard Weight; Grooved Joints: 2-1/2" and Over
- 7. Shutoff Valves: BA-1, BA-1A (STEEL), BF-1, BF-5
- 8. Throttling Valves: BA-9, BF-4, BF-5
- 9. Check Valves: CK-1, CK-4, CK-8
- 10. Strainers: ST-1, ST-2, ST-3

C. Equipment Drains and Overflows:

- 1. Copper; DWV; Soldered: 4" (200 mm) and Under

3.3 TESTING PIPING

- A. Test pipes underground or in chases and walls before piping is concealed.
- B. Complete testing before insulation is applied. If insulation is applied before pipe is tested and a leak ruins the insulation, replace all damaged insulation.
- C. Test the pipe with water at 1.5 times the design pressure but not less than 125 psig pressure. Hold pressure for at least two hours.
- D. Test to be witnessed by the Architect/Engineer or their representative, if requested by the Architect/Engineer.

3.4 CLEANING PIPING

A. Assembly:

1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.
3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

B. Chemical Cleaning:

1. Flush pipe and components with clean water until all discharge from system is clean. Maintain minimum velocities at all points of 5 feet/second for 30 minutes. Flow shall be in same direction as when system is in normal operation. Discharge shall be from low points of pipes, ends of headers and as otherwise needed to flush entire system. After flushing, all residual water shall be drained and/or blown out.
2. Add 2 pounds of trisodium phosphate per 100 gallons of system capacity. Use an alternate chemical if discharge of trisodium phosphate is not permitted. Maintain 150F in the system if possible. If heat is not available, use 3 pounds per 100 gallons.
3. Drain the system after circulating the chemical cleaner for six hours at 150F, or 12 hours at a lower temperature. Refill. Test a water sample. Drain and fill again if excessive cleaning chemicals remain and until water appears clear.
4. After each system has been cleaned and thoroughly flushed of pretreatment chemicals, it shall be immediately refilled with water and treated with chemical treatment as specified in Section 232500. The system shall not be allowed to sit empty for any length of time.
5. When system water is clear, remove, clean and replace all strainer screens (blowing down strainer without removing and cleaning screen is not acceptable).
6. Water samples may be taken by the Architect/Engineer to verify a clean system. If system is not clean, the entire process, including chemical treatment specified in Section 232500, shall be repeated at the Contractor's expense.
7. Chemical cleaning applies to the following systems:
 - a. Heating Water
 - b. Chilled Water
 - c. Glycol Water
 - d. Heating/Cooling Water
 - e. Condenser Water

3.5 INSTALLATION

A. General Installation Requirements:

1. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.
2. Install piping to conserve building space, and not interfere with other work.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
5. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.
6. Install bell and spigot pipe with bells upstream.
7. Seal pipes passing through exterior walls with a wall seal per Section 230529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
8. Branch takeoffs shall be from the top side (if branch is two sizes smaller than main), or any angle from the horizontal plane to the top of piping.

B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment plus its required clearance space.

C. Installation Requirements in MRI (Magnetic Resonance Imaging - Healthcare):

1. All piping in MRI rooms shall be non-ferrous regardless of materials described on Part 2.

D. Valves/Fittings and Accessories:

1. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.
2. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.
3. Provide clearance for installation of insulation, and access to valves and fittings.
4. Prepare pipe, fittings, supports, and accessories for finish painting.
5. Install valves with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.
6. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
7. Provide flanges or unions at all final connections to equipment, traps and valves.
8. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

9. Horizontal swing check valves may only be installed in horizontal position. Do not install horizontal swing check valves in upward or downward flow direction. Where upward or downward flow installation is required, use spring-assisted, non-slam check valve.

3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.
- B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.
- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. 2-1/2" and larger fittings shall be long radius type, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.
- F. Use full and double lengths of pipe wherever possible.
- G. Unless otherwise indicated, install all inlet and outlet piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or pump.
- H. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- I. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

3.7 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate, and venting.
- B. Provide drain valves at all low points of water piping systems or where indicated on drawings for complete or sectionalized draining. Drain valves are defined above.

- C. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install all liquid lines with top of pipe and eccentric reducers in a continuous line.
- D. Provide air vents at all high points and wherever else required for elimination of air in all water piping systems. Do not use automatic air vents in glycol systems unless they are piped to the fill tank.
- E. Air vents shall be in accessible locations. If needed to trap and vent air in a remote location, a 1/8" pipe shall connect the tapping location to a venting device in an accessible location.
- F. All vent and drain piping shall be of same materials and construction as the service involved.

3.8 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.
- B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- C. Use of forged weld-on fittings is also limited as follows:
 - 1. Must have at least same pressure rating as the main.
 - 2. Header or main must be 2-1/2" or over.
 - 3. Branch line is at least two pipe sizes under header or main size.

3.9 JOINING OF PIPE

- A. Threaded Joints (Steel Pipe):
 - 1. Ream pipe ends and remove all burrs and chips.
 - 2. Protect plated pipe and valve bodies from wrench marks when making up joints.
 - 3. Apply Teflon tape to male threads.
- B. Flanged Joints (Steel Pipe):
 - 1. Bronze flanges shall conform to B16.24 and ductile iron flanges to B16.42. Steel flanges shall be raised face except when bolted to flat face cast iron flange.
 - 2. Bolting shall be ASTM A307 Grade B with bolts and heavy hexagonal nuts conforming to ASME B18.2.1 and B18.2.2.
 - 3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.
 - 4. Gaskets for flat face flanges shall be full-face type. Gaskets for raised faced flanges shall conform to requirements for "Group I gaskets" in ASME B16.5. All gaskets shall conform to ASME B16.21. Unless otherwise specified, gaskets shall meet the following requirements:

- a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
- b. Maximum pressure rating of at least 250 psig.
- c. Minimum temperature rating: -10F.
- d. Maximum temperature rating of at least 170F for water and glycol solution systems operating 140F and less.
- e. Maximum temperature rating of at least 250F for water and glycol solution systems operating above 140F and up to 180F.

C. Solder Joints (Copper Pipe):

1. Make up joints with 95% tin and 5% antimony (95-5) solder conforming to ASTM B32 Grade 95TA. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, to all surfaces to be joined. Heat joints uniformly to proper soldering temperature so solder flows to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
2. Flux shall be non-acid type conforming to ASTM B813.
3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470F melting point solder. Remove composition discs and all seals during soldering if not suitable for 470F.

D. Welded Joints (Steel Pipe):

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.
5. Single-welded butt joints may be employed with or without the use of backing rings in all sizes. Where backing rings are not used on pumped pressurized systems, the root side of the weld shall either be chipped or ground flush with the piping wall. For services such as vents, overflows, and gravity drains, the backing ring may be eliminated, and the root of the weld need not be chipped or ground. Backing rings shall be of the material being welded.

E. Mechanically Coupled Grooved Joints (Steel and Copper and HDPE):

1. Grooved connections shall mechanically engage, lock and seal the grooved pipe ends in a positive couple. Each coupling shall have ductile iron housing clamps, steel bolts and nuts, and sealing gasket designed so internal pressure increases the tightness of the seal. Couplings must be installation-ready style for quick installation in sizes through 12" and AGS type for 14" and larger, and no more than two-piece housings.

2. All work, including pipe grooving, shall be accomplished in accordance with manufacturer's published instructions.
3. Final tightening of bolts shall be with a torque wrench to ensure equal tension in all bolts.
4. All fittings shall be provided by one manufacturer. Mixing grooved components is not acceptable.
5. Product Warranty:
 - a. Standard: One-year product warranty. A factory-trained manufacturer's representative shall visit the site for contractor training and installation observation.
 - 1) On-site Training: Manufacturer's factory trained representative shall provide training of contractor's field personnel in use of grooving tools and installation of product. Documentation of installing contractor training with manufacturer's representative shall be submitted to the Architect/Engineer.
 - 2) Job Site Visitation: Manufacturer's representative shall periodically visit job site to ensure manufacturer's installation practices are being followed.
 - b. Extended 15-Year Product Warranty: Manufacturer shall provide extended 15-year warranty to replace product. Warranty shall include onsite training and inspection of all fittings by manufacturer. Manufacturer inspection report shall be provided to the Owner upon completion.
 - c. Extended 15-Year Product and Installation Warranty: Manufacturer shall provide extended 15-year warranty to replace product and any part of the system damaged as a direct result of a failure of the product. Warranty shall include onsite training and inspection of all fittings by manufacturer. Manufacturer inspection report shall be provided to the Owner upon completion.
6. Acceptable Manufacturers: Victaulic, Gruvlok, or Star Fittings.

F. Mechanical Press Connection (Copper):

1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
2. Fully insert tubing into the fitting and mark tubing.
3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
4. Joint shall be pressed with a tool approved by the manufacturer. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

3.10 ACOUSTICAL LAGGING

- A. Where indicated on drawings, completely wrap pipe with lagging and seal all joints airtight with tape recommended by the lagging manufacturer to prevent acoustical leakage at joints. Overlap lagging a minimum of 2" at any joint. Overlap lagging 2" at any wall, floor, or structural deck penetration to prevent acoustical leakage.

END OF SECTION

SECTION 232116 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual Air Vents
- B. Automatic Air Vents
- C. Balancing Valves
- D. Combination Piping Packages
- E. Drain Valves and Blowdown Valves

1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 230500. Include data on pipe materials, fittings, valves, and accessories. Include manufacturers' support spacing requirements for plastic piping.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

1.5 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 230500 for required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 MANUAL AIR VENTS

- A. At end of main and other points where large volume of air may be trapped, use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.
- B. On branch lines and small heating units, use coin-operated air vent equal to B&G #4V, attached to 1/8" coupling in top of pipe. Install air vents on all coils and terminal heating units.

2.2 AUTOMATIC AIR VENTS

- A. Low capacity automatic air vent (for bladder tank anti-thermosyphon loops). Maximum operating pressure and temperature of at least 240F and 125 psi, 1/2" or 3/4" inlet, 3/8" minimum threaded outlet.
 - 1. Manufacturers:
 - a. B&G #87
 - b. Armstrong
 - c. Spirotherm
 - d. Taco 419
 - e. Watts
- B. High capacity automatic air vent (for air separator or high point pipe connection). Brass or cast-iron construction. Maximum 240F and 125 psi operating pressure and minimum of 115 psi system venting pressure, 3/4" inlet, 3/8" minimum threaded outlet.
 - 1. Manufacturers:
 - a. B&G #107
 - b. Armstrong AV
 - c. Spirotherm
 - d. Taco 409
 - e. Watts

2.3 TRIPLE DUTY VALVE

- A. Type TD-1: 2" and above, 175 psi working pressure, flanged, cast iron, non-slam check valve, calibrated throttling, shutoff capabilities, angle or straight pattern. Pressure drop with design flow at 100% open shall not exceed 10 feet. Size to match pipe (not pump outlet) size, but reduce size by not more than one (1) if needed to provide at least 3 feet of differential pressure across the flow measuring taps at scheduled flow rate.
- B. Manufacturers:
 - 1. Armstrong
 - 2. Bell & Gossett

3. Taco
4. Wheatley
5. Victaulic

- C. Triple duty valves may replace the combination of shutoff valve, balancing valve, and check valve on constant volume systems. Triple duty valves are not permitted on variable volume systems.

2.4 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units that sense pressure across a valve). Graph shall extend below the specified minimum flow.
- C. Furnish one meter kit equivalent to Bell & Gossett Model RO-5 meeting the following requirements:
1. Carrying case with handle.
 2. Pressure gauge with 0-25 feet of head scale with 3.0% full scale accuracy.
 3. High and low side hoses with 5 feet length and 250 psig pressure rating, equipped with shutoff valves, vent valves, and probes for insertion into pressure and temperature plugs.
- D. Valves in copper piping shall be brass or bronze.
1. Quarter-Turn Ball Valve Style (Brass or Bronze):
 - a. Manufacturers:
 - 1) Bell & Gossett "Circuit Setter Plus"
 2. Quarter-Turn Venturi Style (Brass or Bronze):
 - a. Manufacturers:
 - 1) Presso "B+"
 - 2) Griswold "Quickset"
 - 3) Gerand "BALVALVE Venturi"
 - 4) Macon Balancing "MB"
 - 5) HCI "Terminator B"
 - 6) Nexus Valve "UltraXB Orturi"
 - 7) IMI Hydronic Engineering "Accusetter"

3. Multi-Turn Style (Brass or Bronze):
 - a. Manufacturers:
 - 1) IMI TA (Tour & Andersson) (STAD)
 - 2) Armstrong "CBV"
 - 3) Victaulic 786
 - 4) Macon STVL/STV
 - 5) MEPCO MBV
 - 6) Wheatly GS
 - 7) NIBCO 1710
 - 8) RWV 951
- E. Valves in ferrous piping 2" or smaller shall have threaded ends and steel, brass or bronze construction. Option to balancing valves noted above are flow sensors specified in Section 230900 with a specified throttling valve.
 1. Quarter-Turn Ball Valve Style (Ferrous Piping less than or equal to 2"):
 - a. Manufacturers:
 - 1) Bell & Gossett "Circuit Setter Plus"
 2. Quarter-Turn Venturi Style (Ferrous Piping less than or equal to 2"):
 - a. Manufacturers:
 - 1) Presso "B+"
 - 2) Gerand "BALVALVE Venturi"
 - 3) Macon Balancing "MB"
 - 4) HCI "Terminator B"
 - 5) Nexus Valve "UltraXB Orturi"
 - 6) IMI Hydronic Engineering "Accusetter"
 3. Multi-Turn Style (Ferrous Piping less than or equal to 2"):
 - a. Manufacturers:
 - 1) IMI TA (Tour & Andersson) "786-789"
 - 2) Armstrong "CBV"
 - 3) Victaulic 787
 - 4) Macon STVL/STV
 - 5) MEPCO MBV
 - 6) Wheatly GSNIBCO 1710 (T1710L)
 - 7) RWV 951
- F. Balancing valves in ferrous piping over 2 size shall have flanged or grooved ends and steel or cast iron construction. Option to balancing valves noted above are flow sensor specified in Section 230900 with a specified throttling valve.

1. Quarter-Turn Ball Valve Style (Ferrous Piping greater than 2"):

a. Manufacturers:

- 1) B&G "Circuit Setter"

2. Quarter-Turn Venturi Style (Ferrous Piping greater than 2"):

a. Manufacturers:

- 1) Presso "B+"
- 2) Taco "Accu-flo"
- 3) Macon Balancing "MB"
- 4) HCI "Terminator G"
- 5) Nexus Valve "Nextrol NXFB"
- 6) IMI Hydronic Engineering "Accusetter"

3. Multi-Turn Style (Ferrous Piping greater than 2"):

a. Manufacturers:

- 1) Armstrong "CVB-II"
- 2) IMI TA (Tour & Andersson) (STAF, STAG)
- 3) Victaulic 788/789
- 4) Macon STVA / E
- 5) MEPCO MBV
- 6) NIBCO 737
- 7) RWV 951

G. Balancing valves in ferrous piping over 2" size shall consist of flow sensors as specified in Section 230900 combined with specified throttling valves.

H. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.5 COMBINATION PIPING PACKAGES

A. Combination piping packages are allowed at unitary equipment only (1" pipe size and smaller) in lieu of individual components specified for hydronic coils and devices containing hydronic coils. Configuration of combination pieces shall match layouts on the drawings. Each component of the combination piping packages shall meet these specifications for the individual components being combined. Coil connections shall be rigid. Combination piping packages shall include:

1. Shutoff valves
2. Wye strainers, with minimum 1/4" turn strainer blowdown valves with hose thread and cap
3. Manual balancing valves with memory stop. Automatic flow control devices are allowed.
4. Test plugs
5. Manual air vents
6. Unions

B. Manufacturers:

1. FDI Flowset
2. Griswold
3. Hays Fluid Controls
4. HCI Terminator
5. Nexus Coil Pak
6. Victaulic

2.6 DRAIN VALVES AND BLOWDOWN VALVES

- A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

2.7 CONNECTIONS BETWEEN DISSIMILAR METALS

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel, and stainless steel are commonly used and require isolation from each other with the following exceptions:
1. Iron and steel connected to each other.
 2. Brass, copper, and bronze connected to each other.
 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
1. Dielectric waterway rated for 300 psi CWP and 225F.
 2. Manufacturers:
 - a. Elster Group ClearFlow fittings
 - b. Victaulic Series 647
 - c. Grinnell Series 407
 - d. Matco-Norca
- F. Flanged Joints (any size):
1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.

2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
6. Manufacturers:
 - a. EPCO
 - b. Central Plastics
 - c. Pipeline Seal and Insulator
 - d. F.H. Maloney
 - e. Calpico

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valves/Fittings and Accessories:

1. Where a manual balance valve is shown to be installed in series with a service (isolation) valve, separate balance and service (isolation) valves shall be installed.
2. Install balancing valves with the manufacturer's recommended straight upstream and downstream diameters of pipe.

Product	Upstream Diameters	Downstream Diameters
		Diameters
Griswald "Quickset"	0	0
Fluid Design "Accusetter"	0 up to 2" size	0
	5 for larger sizes	
Presso "B+"	5	2
Taco "Accu-flo"	10	5
IMI TA (Tour & Andersson) 786-789	5 after fittings	2
	10 after pumps	
Bell & Gossett "Circuit Setter Plus"	3	1
Bell & Gossett "Circuit Setter"	3 up to 4" size	1 up to 4" size
	5 above 4" size	2 above 4" size

Armstrong "CVB" and "CVB-II"	10	5
Gerand "BALVALVE Venturi"	5	2
NIBCO 1710/737	5	3

3. Prepare accessories for finish painting.
4. Install accessories with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.
5. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
6. Provide flanges or unions at all final connections to equipment, traps and valves.
7. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

3.2 ACOUSTICAL LAGGING

- A. Where indicated on drawings, completely wrap pipe with lagging and seal all joints airtight with tape recommended by the lagging manufacturer to prevent acoustical leakage at joints. Overlap lagging a minimum of 2" at any joint. Overlap lagging 2" at any wall, floor, or structural deck penetration to prevent acoustical leakage.

END OF SECTION

SECTION 232123 - HVAC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. All pumps except where integral with a manufactured piece of equipment.
- B. Pump controls where self-contained.

1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 230500.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Submit motor data indicating compliance with Section 230513.
- D. Submit certification that pumps, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:
 - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 PUMPS - GENERAL

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 RPM unless specified otherwise.
- D. Pump connections shall be flanged, whenever available.

- E. Heating pumps shall be suitable for 225F water.
- F. Motors shall comply with Section 230513 including, but not limited to:
 - 1. Single phase motors less than 1 HP shall be electronically commutated or shall have a minimum motor efficiency of 70%.
 - 2. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service.
 - 3. All 480 volt motors driven by VFDs shall be provided with shaft grounding rings or grounding brushes or ceramic bearings as a means to protect bearings from adverse shaft currents.
- G. Pump impellers shall not have smaller diameters than those scheduled. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.
- H. Pumps specified in this section operating in clean water with a flow greater than 25 GPM and less than 459 feet head shall have a maximum Pump Energy Index (PEI) as scheduled on the drawings. In no case shall the PEI exceed 1.0.

2.2 IN-LINE PUMP

- A. Type: Centrifugal, single stage, close coupled in-line, back pullout design, suitable for horizontal or vertical operation.
- B. Casing: Cast iron, rated for greater of 125 psi or 1.5 times actual working discharge pressure, flanged suction and discharge with gauge ports.
- C. Impeller: Bronze or stainless steel, fully enclosed, dynamically balanced, keyed to shaft and secured with locknut.
- D. Shaft: Steel or stainless steel.
- E. Seals: Mechanical type with internal flushing rated for -20F to 225F and comprised of Buna elastomer, carbon primary ring, and ceramic stationary ring.
- F. Seals: Mechanical type rated for -20F to 250F with EPR or EPT bellows and seat gasket, carbon primary ring, and silicon-carbide stationary ring.
- G. Manufacturers:
 - 1. Bell & Gossett
 - 2. Taco
 - 3. Aurora
 - 4. Armstrong
 - 5. Grundfos/Peerless/PACO
 - 6. Patterson
 - 7. Weinman/Crane

2.3 IN-LINE CIRCULATORS

- A. Wet rotor, single stage, in-line, back pullout design, suitable for horizontal or vertical operation.
- B. Cast iron or stainless steel, rated for greater of 125 psi (865kPa) or 1.5 times actual working discharge pressure, flanged suction and discharge with gauge ports.
- C. Bronze or stainless-steel impeller, fully enclosed, dynamically balanced, keyed to shaft and secured with locknut.
 - 1. Shaft: Steel or stainless steel.
- D. Self-contained controls of proportional pressure, constant pressure and constant speed with MODBUS or BACnet interface. Pump provided with a status display on the pump.
- E. Manufacturers:
 - 1. Bell & Gossett
 - 2. Taco
 - 3. Grundfos
 - 4. Wilo

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
 - 1. Install all products per manufacturer's recommendations.
 - 2. Support piping adjacent to pumps so that no weight is carried by pump casings. Provide supports under elbows on 4" and larger pump suction and discharge pipes. Allow a minimum of 18" clearance for removal of suction diffuser.
 - 3. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
 - 4. Install on vibration isolators as scheduled on drawings.
 - 5. Where electronically commutated motors are equipped with manual speed adjustment, pump speed shall be adjusted during the testing, adjusting, and balancing phase to achieve scheduled performance.
- B. In-Line Pumps:
 - 1. Support in-line pumps individually so there is no strain on the piping. Install with a minimum of five diameters of straight pipe on pump suction and discharge.
 - 2. Pump orientation shall be in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 233100 - DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Galvanized Ductwork
- B. Stainless Steel Ductwork
- C. Ductwork Reinforcement
- D. Ductwork Sealants
- E. Rectangular Ductwork
- F. Round and Flat Oval Ductwork
- G. Exposed Ductwork (Rectangular, Round, or Oval)
- H. Flexible Duct
- I. Fume Exhaust Duct
- J. Leakage Testing
- K. Ductwork Penetrations
- L. Duct Cleaning
- M. Painting

1.2 SUBMITTALS

- A. Submit shop drawings per Section 230500.
- B. Submit duct fabrication standards in compliance with SMACNA and these specifications. Clearly indicate metal gauges, reinforcement, and joining methods intended for use for each pressure classification. Furnish details of all common duct fittings and joint connections to be used on this project.
- C. The Architect/Engineer may require field verification of sheet metal gauges and reinforcing to verify compliance with these specifications. At the request of the Architect/Engineer, the contractor shall remove a sample of the duct for verification. The contractor shall repair as needed.

- D. Duct Layout Drawings: Submit detailed duct layout drawings at 1/4" minimum scale complete with the following information:
1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
 2. Differentiate ducts that are wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
 3. Room names and numbers, ceiling types, and ceiling heights.
 4. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
 5. Verify clearances and interferences with other trades prior to preparing drawings. IMEG will provide electronic copies of ventilation drawings for contractor's use if the contractor signs and returns the "Electronic File Transfer" waiver. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for this submittal. Refer also to Section 230500.
- E. Duct Leakage Test Summary Report: Upon completion of the pressure test described in Part 3, the Contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.

1.3 DEFINITIONS

- A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
- B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.
- C. Exterior Duct: Ductwork located outside the conditioned envelope including exposed ductwork above the roof, outside exterior walls, in attics above insulated ceilings, inside parking garages, and crawl spaces.
- D. Interior Duct: Ductwork located within the conditioned envelope including return air plenums and indirectly conditioned spaces.

1.4 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 230500 for required duct systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.
- B. Duct drawings shall be at 1/4" minimum scale complete with the following information:
1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
 2. Differentiate ducts that are lined or wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
 3. Location and size of all duct access doors.
 4. Room names and numbers, ceiling types, and ceiling heights.

5. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
6. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings. Architectural plans will need to be obtained from the Architect.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS AND SUPPORTS

A. Rectangular Duct - Single Wall:

1. General Requirements:
 - a. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
 - b. Transitions shall not exceed the angles in Figure 4-7.
2. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:
 - a. All ducts shall be cross-broken or beaded.
 - b. Snap lock seams are not permitted.
 - c. Turning vanes shall be used in all 90-degree mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:
 - 1) Type 1:
 - a) Description: Single wall type with 22-gauge (0.029") or heavier vanes, 3-1/4" blade spacing, and 4" to 4-1/2" radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra-long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.
 - b) Usage: Limited to 3,000 fpm and vane lengths 36" and under.
 - 2) Type 2:
 - a) Description: Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.
 - b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.

- 3) Type 3 (acoustical - where acoustical lagging is located or as noted on drawings):
 - a) Description: Same as Type 2, except filled with fiberglass and with slotted or perforated inner curve. Minimum insertion loss of 9 dB at 250 Hz and 6 dB at 1 KHz.
 - b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.
 - 4) Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.
 - 5) Runners must be installed at a 45-degree angle. Elbows with different size inlet and outlet must be radius type.
 - 6) Omitting every other vane is prohibited.
- d. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. Mitered elbows (with or without turning vanes) may not be substituted for radius elbows. Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.
 - e. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45-degree entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.
 - f. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.
 - g. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45-degree rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.
 - h. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30-degree maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30-degree angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.
 - i. All lined duct shall utilize dovetail joints where round or conical taps occur. The dovetail joints shall extend past the liner before being folded over.
 - j. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2 " pressure class, and must be less than 6" in length.

- k. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
 - 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
 - 2) Manufacturers:
 - a) Ductmate Industries - 25/35/45
 - b) Nexus
 - c) Mez
 - d) WDCI
 - e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.
- l. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
 - 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
 - 2) Flanges shall be 24-gauge minimum (not 26 gauge).
 - 3) Manufacturers:
 - a) Lockformer TDC
 - b) TDF
 - c) United McGill
 - d) Sheet Metal Connectors
 - e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

B. Round and Flat Oval Spiral Seam Ductwork - Single Wall:

- 1. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Architect/Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
- 2. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.
- 3. 90-degree elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.

4. Duct and fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.
5. Ductwork shall be suitable for velocities up to 5,000 fpm.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Ducts with minor axis less than 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
9. Reinforce flat oval ducts with external angles. Internal tie rods are permitted only as indicated for rectangular ductwork.
10. Transverse Joint Connections:
 - a. Crimped joints are not permitted.
 - b. Ducts and fittings 36" in diameter and smaller shall have slip joint connections. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
 - c. Ducts and fittings larger than 36" shall have flanged connections.
 - d. Secure all joints with at least 3 sheet metal screws before sealing.
 - e. Manufacturers, Slide-on Flanges:
 - 1) Ductmate Industries - SpiralMate
 - 2) Accuflange
 - 3) Sheet Metal Connectors are acceptable.
 - f. Manufacturers, Self-Sealing Duct Systems:
 - 1) Lindab
 - 2) Ward "Keating Coupling"

C. Round Snap-Lock Seam Ductwork - Single Wall:

1. Factory sealed snap-lock pipe. Transverse and longitudinal seams shall contain factory-applied self-sealing EPDM and co-polymer gasket. Snap-lock shall conform to SMACNA RL-8. Duct and gasket material shall meet the flame/smoke spread rating of 25/50 per ASTM-E84.
2. G-60 galvanized coating meeting ASTM A653 and ASTM A90 G-90 galvanized steel aluminum meeting ASTM B209 Alloy 3003 Temper H14 304 stainless steel meeting ASTM A480 2B Finish.
3. Snap-lock seams are only permitted on systems between -1"w.c. and 2"w.c. pressure class.
4. 90-degree elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
5. Duct and fittings shall meet the required minimum gauges listed in Chapter 3 of the SMACNA requirements for the specified pressure class.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.

7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Manufacturers:
 - a. GreenSeam Industries.

D. Hangers and Supports General Requirements:

1. Hanger and support materials shall be as defined within Materials and Application Specific section below.
2. Strap Hangers: Strap hanger shall be a minimum of 1 inch, 18 gauge attached to the bottom of ducts.
3. Cable Hangers:
 - a. Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork.
 - b. Manufacturers; Supports:
 - 1) Gripple
 - 2) Ductmate
 - 3) Duro Dyne
 - 4) Architect/Engineer approved
4. Integral Corner Connector Hanger: Integral hanger and corner assembly for use with TDC/TDF style duct flanges. Die stamped offset hanger connects to the flanged corner assembly. For use with aircraft cable or 1/4" or 3/8" diameter threaded rods. Tested to hold up to 1,400 lbs. Install per manufacturer's ratings and instructions.
 - a. Manufacturers; Supports:
 - 1) EZ Hanger

2.2 MATERIAL AND APPLICATION SPECIFIC

A. Galvanized Steel:

1. General Requirements:
 - a. Duct and reinforcement materials shall conform to ASTM A653 and A924.
 - b. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
 - c. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.
 - d. Ductwork reinforcement shall be of galvanized steel.

2. Duct Hangers and Support Material:
 - a. Ductwork hangers and supports shall be of galvanized or painted steel.
 - b. All fasteners shall be galvanized or cadmium plated.
- B. Stainless Steel Ductwork:
 1. General Requirements:
 - a. Ductwork shall be Type 304L stainless steel, 16 gauge minimum.
 - b. Ductwork shall be Type 316L stainless steel, 16 gauge minimum.
 - c. Exposed ductwork shall have a #3 finish. Concealed ductwork may have milled finish.
 - d. Ductwork reinforcement shall be of stainless steel.
 2. Duct Hangers and Supports Material:
 - a. Ductwork hangers and supports shall be of stainless steel. Slip cable hangers are acceptable if constructed of stainless steel.
 - b. All fasteners shall be stainless steel or cadmium plated steel.
- C. Duct Hangers and Support Material:
 1. Ductwork hangers and supports shall be of galvanized or painted steel.
 2. All fasteners shall be galvanized or cadmium plated.
- D. Exposed Ductwork (Rectangular, Round, and Flat Oval):
 1. The following applies to all ductwork exposed in finished areas in addition to requirements noted above:
 - a. Provide extra shipping protection. Use Cardboard or other protective means to prevent dents and deformed ends.
 - b. Provide cardboard or other means of protection during field fabrication. Protect from scratches. Provide stiffeners to retain shape during fabrication.
 - c. Remove all identification stickers and thoroughly clean exterior of all ducts.
 - d. Locate fitting seams on least visible side of duct.
 - e. Provide exterior finish suitable for field painting without further oil removal.
 - f. Provide ramp-type internal joint couplings. Provide bead of sealant around the inside of the duct about 1/2" from the end of the duct.
 - g. Manufacturers, Slide-on Flanges:
 - 1) Ductmate Industries
 - 2) Accuflange
 - 3) Sheet Metal Connectors
 - h. Manufacturers, Self-Sealing Duct System:
 - 1) Lindab
 - 2) Ward "Keating Koupling"

- i. The system shall be free of visible dents and scratches when viewed from normal occupancy.
 - j. All insulation shall be internal, except at reheat coils.
- 2. In addition to the paragraphs above, this section applies to all ductwork specified or shown as "Architecturally Exposed":
 - a. All spiral ductwork fittings shall be carbon arc welded.
 - b. Grind all welds to remove irregularities.
 - c. Conical taps shall be one piece. Taps for grilles and takeoffs shall be factory installed with a continuous weld and ground smooth.
 - d. Welds shall be ground smooth and painted.
 - e. All architecturally exposed ducts shall be round or flat oval except where not possible (grilles, reheat coils, etc.).
- 3. Alternate manufacturers, including shop fabricated duct, must be reviewed before installation. The following information is required:
 - a. Metal gauge of duct and fittings.
 - b. Fitting type and construction.
 - c. Type and size of reinforcement.
- 4. Hangers for Exposed Ductwork:
 - a. Round Ducts:
 - 1) Threaded rod with duct fixing bracket and metal strap. Provide single threaded rod centered on the duct. Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel wrapping the circumference of the duct. Spacing as required by SMACNA guidelines.
 - 2) Aircraft cable with 2-point support in standard horseshoe arrangement.
 - b. Strut-channel and all-thread rod is not acceptable for exposed ductwork.
 - c. All fasteners shall be galvanized or cadmium plated.
- E. Fume Exhaust Duct:
 - 1. Stainless Steel:
 - a. Unless shown otherwise on the drawings, all fume exhaust ductwork shall be 16 gauge Type 304L stainless steel with continuously welded joints. Ductwork shall meet all requirements of SMACNA Class 5-6" pressure class industrial ductwork. Use heavier gauge and/or transverse reinforcements if required.
 - b. Elbows up to 30 degrees shall be mitered two-piece type. Elbows 31 degrees to 50 degrees shall be mitered three-piece type. Elbows 51 degrees to 90 degrees shall be mitered five-piece type. All elbows shall have a minimum centerline R/D of 1.5. Elbows 10" in diameter and smaller may be die-formed.

- c. Expanders in horizontal ducts shall be eccentric type with a minimum length of (diameter change x 10) and shall maintain a positive pitch for drainage to the fume hood or exhaust outlet. Expanders in ducts over 30 degrees from horizontal shall be concentric with a minimum length of (diameter change x 5).
- d. Ducts shall maintain the maximum possible pitch toward their inlets unless a different drainage location is indicated on the drawings. If at least 1/8" per foot pitch cannot be maintained, notify the Architect/Engineer before installing ductwork or other items with which ductwork may conflict.
- e. All welds shall conform to AWS D9.1M. Welds shall be Gas Tungsten Arc Weld (TIG) or Gas Metal Arc Weld (MIG) type. All filler metal shall conform to AWS A5.9 or A5.22 and be AWS Classification ER308L or ER308LSi with a carbon content of not over 0.03%.
- f. Supports shall not penetrate duct surfaces. Ductwork shall be completely leak-tight from the inlet to the discharge to the atmosphere, at pressures up to 10" WG. Install caps to seal the ductwork for pressure testing. Plug all spray and drain connections when testing ductwork.
- g. Where flanged joints are indicated, they shall have 1/4" "Gore-Tex Joint Sealant" gaskets (W. L. Gore & Associates, Industrial Products Division, 100 Airport Road, Box 1550, Elkton, MD 21921 (410) 392-4440 or (410) 392-3200). PTFE gaskets are also acceptable.
- h. Furnish one 50' spool of gasket material or 10 spare gaskets of each size used to the Owner for future use.
- i. All ducts indicated as "316SS" shall be constructed of Type 316L stainless steel. The specification above for 304L stainless steel ductwork also applies to 316L stainless steel ductwork except all filler metal shall be AWS Classification ER316L with a carbon content of not over 0.03%.
- j. Do not penetrate fire rated partitions, unless protected as required by applicable codes.

2.3 DUCTWORK REINFORCEMENT

- A. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.
 - 1. Ducts must be over 18" wide.
 - 2. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
 - 3. Tie rods must not exceed 1/2" diameter.
 - 4. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

2.4 DUCTWORK SEALANTS

- A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20F to +175F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M. Joint sealers for use on exterior weather exposed ductwork shall be rated for -30F to +175F and 2000-hour minimum UV resistance per ASTM G-53.
- B. Two-part joint sealers shall consist of a minimum 3" wide mineral-gypsum compound impregnated fiber tape and a liquid sealant. Sealant system shall meet the following requirements: maximum 48-hour cure time, service temperature of 0F to 200F, resistant to mold, mildew, and water, flame spread rating below 25 and smoke developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Joint sealers for use on exterior weather exposed ductwork shall be rated for -30F to +175F and 2000-hour minimum UV resistance per ASTM G-53.
- C. Pressure sensitive tape used for sealing ductwork shall be minimum 2.5-inch wide, listed and marked UL 181A-P, having minimum 60 oz/inch peel adhesion to steel, and service temperature range from -20F to +250F.
- D. Where pressure sensitive tape is called for on drawings and specifications for sealing flexible ductwork, tape shall be minimum 2.5-inch wide, UL 181 B-FX listed, and marked tape having minimum 60 oz/inch peel adhesion to steel and service temperature range from -20F to +250F.
 - 1. Manufacturers, Pressure-Sensitive Tape:
 - a. Venture Tape 1581A
 - b. Compac #340
 - c. Scotch Foil Tape 3326
 - d. Polyken 339

2.5 FLEXIBLE DUCT

- A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.
- B. Flame Spread/Smoke Developed: Not over 25/50.
- C. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.
- D. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.

E. Acoustic:

1. Flexible duct shall be acoustic rated in accordance with ASTM E477 and ADC Test Code FD 72-RI by ETL. Insertion loss values noted below are for flow velocities less than 2,500 fpm. Submittals shall include insertion losses ratings per sizes and lengths listed below regardless of sizes shown on the drawings.
2. Flexible have corrosion-resistant wire helix, bonded to a nylon fabric core inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh. Usage: All areas unless noted otherwise.
3. Inner liner shall be airtight and suitable for 6" WC static pressure through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "R" value shall not be less than 4.0 ft²*F*hr/Btuh. Temperature range of at least 0 to 180F. Maximum velocity of 4,000 fpm. "R" value shall not be less than 4.0 ft²*F*hr/Btuh.
4. Minimum Acoustic Insertion Losses per octave band:

a. Straight Duct:

Dia	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" ø	6 ft	4.0	13	15	15	16	17	16
6" ø	3 ft	2.3	4.9	5.3	5.3	5.5	5.8	5.4
8" ø	6 ft	5.7	14	13	15	16	18	16
8" ø	3 ft	2.9	5.0	4.9	5.7	5.6	5.8	5.6
12" ø	6 ft	5.5	13	12	15	15	18	13
12" ø	3 ft	2.8	4.8	4.7	5.3	5.3	5.8	4.9

b. 90deg Elbow:

Dia	Length	63h z	125h z	250h z	500h z	1000hz	2000h z	4000hz
6" ø	6 ft	10	15	16	17	18	17	18
6" ø	3 ft	3.8	5.4	5.5	5.7	5.9	5.8	5.9
8" ø	6 ft	10	15	16	17	16	18	18
8" ø	3 ft	2.4	5.3	5.6	5.8	5.6	5.9	6.0
12" ø	6 ft	11	14	15	16	15	16	15
12" ø	3 ft	4.4	5.1	5.3	5.5	5.4	5.6	5.3

5. Usage:

- a. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.
- b. Connections to air inlets and outlets. Do not exceed 5'-0" in length.

c. Acceptable Manufacturers:

- 1) Flexmaster USA - Type 6
- 2) Thermaflex M-Ke

F. Radius Forming Elbows:

1. Flexible plastic radius forming elbow for use with flexible ducts to create 90deg elbow. One size for 6" to 16" diameter ducts. UL listed for return plenum spaces.
2. Usage: All supply air terminals with flexible ductwork connection.
3. Installation: Attach to flex duct and secure draw bands without crushing flex duct to form smooth radius elbow. Suspend radius forming elbow to structure. Install per manufacturer's instructions.
4. Acceptable Manufacturers:
 - a. Hart & Cooley - Smartflow
 - b. Thermaflex - Flexflow
 - c. Titus - Flexright

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide openings in ducts for thermometers and controllers.
- B. Locate ducts with space around equipment for normal operation and maintenance.
- C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms.
- D. Provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.
- E. Supply ductwork shall be free of construction debris, and shall comply with Level "C" of the SMACNA Duct Cleanliness for New Construction Guidelines.
- F. Repair all duct insulation and liner tears.
- G. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.
- H. Insulate terminal air box reheat coils. Seal insulation tight to form a tight vapor barrier.
- I. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.

- J. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.
- K. Install all exterior ductwork per SMACNA Fig. 6-3. Where drawings do not indicate otherwise, ductwork seams and joints shall be sealed watertight and pitched to shed water.
- L. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible and the SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, where applicable. Refer to Section 230550 for seismic requirements.
- M. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.
- N. All duct support shall extend directly to building structure. Do not support ductwork from pipe hangers unless coordinated with piping contractor prior to installation. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.
- O. Kitchen Grease and Dishwasher Ductwork:
 - 1. All kitchen grease and dishwasher ductwork shall be installed with a continuous slope and liquidtight welds on all seams and joints.

3.2 DUCTWORK APPLICATION SCHEDULE

- A. Refer to Ductwork Application Schedule below for specific requirements for system, material, shape, pressure class, seal class and insulation application.
- B. Supply Duct from Fan to Terminal Air Boxes:
 - 1. Shape: Rectangular Duct or Round and Flat Oval Ductwork- Single Wall
 - 2. Material: Galvanized Steel
 - 3. Pressure Class: +4"
 - 4. Seal Class: A
 - 5. Insulation: 1-1/2" thick Type A (R=4.5)
 - 6. Additional Requirements: None
- C. Supply Duct from Terminal Air Boxes to Terminal Air Outlets:
 - 1. Shape: Rectangular Duct or Round and Flat Oval Ductwork - Single Wall
 - 2. Material: Galvanized Steel
 - 3. Pressure Class: +2"
 - 4. Seal Class: A
 - 5. Insulation: 1-1/2" thick Type A (R=4.5)
 - 6. Additional Requirements: None

D. Return Duct:

1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: -2"
4. Seal Class: A
5. Insulation:
 - a. Arkansas Energy Code 2014: None
6. Additional Requirements: None

E. General Exhaust Duct:

1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: -1"
4. Seal Class: A
5. Insulation: None
6. Additional Requirements: None

F. Fume Exhaust Duct:

1. Shape: Refer to "Fume Exhaust Duct"
2. Material: Stainless Steel
3. Pressure Class: -4"
4. Seal Class: A
5. Insulation: 1-1/2" thick Type A (R=4.5) within 15' of penetration of exterior wall or roof

3.3 SPECIAL INSULATION REQUIREMENTS

A. Ductwork Accessories (Fabric Flex Connectors, Equipment Flanges, etc.):

1. Insulation:
 - a. IECC-2021: 1-1/2" thick Type A (R=4.5)

B. All Terminal Air Box/ Reheat Coil Headers and Duct Mounted Coil Headers:

1. Insulation: 1-1/2" thick Type A (R=4.5)

C. Linear Diffuser Supply Plenum:

1. Insulation:

- a. Arkansas Energy Code 2014: 1-1/2" thick Type A (R=4.5)

3.4 DUCTWORK SEALING

A. General Requirements:

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.
4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.

B. All ducts systems, regardless of pressure class, shall be Seal Class A as defined by Section 5-1 of SMACNA HVAC Air Duct Leakage Test Manual per the Energy Code, unless specifically noted otherwise. Seal Class A shall include sealing of all transverse joints, longitudinal seams, and duct wall penetrations with welds, gaskets, mastics, or fabric-embedded mastic system. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.

C. Double-wall ductwork: Install insulation end fittings at all transitions from double to single-wall construction.

D. Special Requirements for Dedicated Outside Air Systems (DOAS):

1. Apply aluminum-based adhesive sealant tape at non-flanged joints on ducts serving dedicated outside air supply (DOAS) and exhaust system in addition to Class A sealant.
2. Apply aluminum-based adhesive sealant tape on TAB boxes (all seams and joints of the box and duct connections) serving dedicated outside air supply (DOAS) system.

3.5 TESTING

A. Interior Duct - Less than 3" WG (positive or negative):

1. Leak testing of these pressure classes is not normally required for interior ductwork (inside the building envelope). However, leak tests will be required if, in the opinion of the Architect/Engineer, the leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.
2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
3. Seal ducts to bring the air leakage into compliance.
4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

B. Interior Duct - 3" WG and Above (positive or negative):

1. A minimum of 25% of interior ductwork (inside the building envelope) shall be tested. The Owner or designated representative shall select the sections to be tested. If duct has outside wrap, testing shall be done before it is applied.
2. Duct system shall be completely pressure tested or aerosol sealed and tested. If duct has outside wrap, testing shall be done before it is applied.
3. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
4. Seal ducts to bring the air leakage into compliance.
5. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

C. Exterior Duct - 1/2" WG and Above (positive or negative):

1. All exterior ductwork (outside the building envelope) shall be completely pressure tested. If duct has outside wrap, testing shall be done before it is applied.
2. All exterior ductwork (outside the building envelope) shall be completely pressure tested or aerosol sealed and tested. If duct has outside wrap, testing shall be done before it is applied.
3. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
4. Seal ducts to bring the air leakage into compliance.
5. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

D. Pressure Test Procedure:

1. Testing shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:
 - a. The required leakage class for Seal Class A, rectangular ducts, shall be 4; round shall be 2.
 - b. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.

- c. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
- d. All joints shall be felt by hand, and all discernible leaks shall be sealed.
- e. Totalling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.
- f. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Architect/Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.
- g. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.
- h. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.
- i. Positive pressure leakage testing is acceptable for negative pressure ductwork.

E. Aerosol Sealed and Tested Procedure

1. Duct Preparation

- a. Inspect air distribution systems for major leakage sites and significant accumulation of hubris or debris.
- b. Remove all debris and significant dust and dirt (greater than 1/8 inch deep) in air distribution system using NADCA approved duct cleaning method.
- c. Ensure adequate structural support for new and existing ductwork, including structural integrity of all mechanical duct joints and transitions per SMACNA standards.
- d. Temporarily remove or protect from aerosol particles building controls, fire and smoke sensors as recommended by manufacturer.
- e. Temporarily disable fire alarms and notify appropriate authorities.
- f. Temporarily isolate air-moving equipment and block off air inlets and outlets, and other devices and appurtenances as recommended by the manufacturer.
- g. Protect occupied spaces from aerosol particles using manufacturer procedures.
- h. All work shall be done in a substantial and workmanlike manner by factory trained technicians.

2. Duct Sealing

- a. Repair all major leakage sites greater than 1/2 inch across using mastic and fiberglass mesh tape per SMACNA standards.
- b. Mastic and fiberglass mesh tape shall meet UL 181 standards.
- c. Seal existing ductwork from the inside using automated aerosolized sealant injection.
 - 1) Manufacturer: Aero seal LLC, 225 Byers Rd., Miamisburg, OH 45342, 937-428-9300, www.aeroseal.com
 - 2) Application must be performed by a manufacturer approved service provider.
 - 3) Sealant shall comply with UL Outline Scope 1381.

- 4) Sealant must cure with 2 hours with no VOC off-gassing thereafter.
 - 5) Sealant shall remain elastic after curing.
 - 6) Sealant shall be deposited substantially at areas of leakage only.
 - d. Provide pre-sealing, post-sealing and sealing profile reports for all duct sections sealed.
 - e. Repair all injection and test holes in existing ductwork using patching plates sealed tight per SMACNA standards.
 - f. Any injection ports in duct board shall be made and repaired using pump-kin-cuts.
 - g. Any insulation (internal or external) shall be replaced on the patching plate.
3. Duct Testing
 - a. Provide pre-sealing and post-sealing leakage profile reports indicating percentage reduction of leakage for supply, return and exhaust ductwork and shafts.
 - b. Use manufacturer calibrated blower fan box with digital manometer to measure leakage before and after sealing.
 - c. Following completion of air handling unit installations, duct repairs, and duct sealing, test all ductwork to ensure that the air distribution system is properly sealed.
 - 1) The supply ducts shall have air losses of less than 3% of the total air flow volume measured at the fan or air-moving device.
 - 2) The return ducts shall have air losses of less than 3% of the total air flow volume measured at the fan or air-moving device.
 - 3) The exhaust ducts shall have air losses of less than 5% of the total air flow volume measured at the fan or air-moving device.
 - 4) Ducts shall be leak tested at a static pressure that is as close as possible to the system average operating static pressure. Duct test pressure should not exceed the lesser of the duct static pressure construction class, the duct system design static pressure or 2.5 in. w.g.
4. Duct Reassembly and Cleanup
 - a. Reinstall building controls and smoke detectors.
 - b. Enable fire alarms and notify appropriate authorities.
 - c. Remove blocking, reinstall grills and registers, and enable air handling fans.
 - d. Cleanup sealant residue that may have adhered to surfaces in occupied areas as recommended by the Manufacturer.
 - e. All work shall be done in a substantial and workmanlike manner by factory-trained technicians
5. Warranty
 - a. The Contractor shall warrant that the aerosol sealant application will be free of defects for a period of 3 years from date of the sealing application. If defects should occur during this period, the Contractor shall repair or replace the defective duct seals, including the direct labor costs for performing the repair or replacement, at no additional cost to the Owner.

F. Fume Exhaust Duct:

1. Testing shall be done before any exterior insulation is applied.
2. Cap each exhaust system at all inlets and at the discharge to atmosphere. Fans, dampers and flexible connections shall be included in the testing.

3. Pressurize each duct system to 7" water column. Leakage shall not exceed 4 CFM regardless of system size.
4. Where several fans discharge into a large collection duct, the collection duct and each individual exhaust duct may be treated as separate systems.

3.6 DUCTWORK PENETRATIONS

- A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.
- B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Architect/Engineer.
- C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install trim strip to cover vacant space and raw construction edges of all openings in finished rooms. Install escutcheon ring at all round duct openings in finished rooms. Trim strips and rings shall be same material and finish as exposed duct.

3.7 ACOUSTICAL LAGGING

- A. Where indicated on drawings, completely wrap ductwork with lagging and seal all joints airtight with tape recommended by the lagging manufacturer to prevent acoustical leakage at joints. Overlap lagging 2" at any wall, floor, or structural deck penetration to prevent acoustical leakage.

3.8 PAINTING

- A. Paint interior of ducts black within twice the largest duct dimension of inlets and outlets where interior of duct is visible.
- B. Paint bottom of ducts black within twice the largest duct dimension where a duct is routed above an unducted perforated grille and the duct is visible.

END OF SECTION

SECTION 233300 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual Volume Dampers.
- B. Fabric Connectors.
- C. Drip Pans.
- D. Duct Access Doors.
- E. Duct Access Sleeve.
- F. Duct Test Holes.
- G. Remote Volume Control Devices.

1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 230500.
- B. Submit manufacturer's installation instructions.
- C. Submit certification that ductwork accessories will withstand seismic forces defined in Section 230550. Include the following:
 - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 MANUAL VOLUME DAMPERS

- A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.
- B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.
- C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.
- E. Provide locking quadrant regulators on single and multi-blade dampers.
- F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
- G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.
- H. Contractor assembled modular manual dampers are acceptable as long as it contains the components listed above.

2.2 FABRIC CONNECTORS

- A. Fabric connectors shall be installed between all fans or fan units and metal ducts or casings to prevent transfer of fan or motor vibration.
- B. The fabric connectors shall be completely flexible material which shall be in folds and not drawn tight.
- C. Fabric connectors shall be of glass fabric double coated with neoprene, with UL approval. Weight = 30 oz. per square yard minimum. Fabric shall not be affected by mildew and shall be absolutely waterproof, airtight and resistant to acids, alkalis, grease and gasoline, and shall be noncombustible.
- D. Fabric connections shall not exceed 6" in length on ductwork that has a positive pressure. On ductwork that has a negative pressure, the length shall not exceed 2" in length.
- E. All corners shall be folded, sealed with mastic and stapled on 1" centers.
- F. Fabric connectors shall not be painted.
- G. Unless otherwise shown on the drawings, the fabric connection at the inlet to centrifugal fans shall be at least one duct diameter from the fan to prevent inlet turbulence.

H. Materials:

1. Durodyne MFN-4-100
2. Vent Fabrics, Inc.
3. "Ventglas"
4. Proflex PFC3NGA

I. Fabric connectors exposed to sunlight and weather shall be as described above, except the coating shall be hypalon in lieu of neoprene.

J. Materials:

1. Durodyne "Duralon MFD-4-100"
2. Vent Fabrics, Inc.
3. "Ventlon"
4. Proflex PFC3HGA

2.3 DRIP PANS

- A. Install drip pans under all rooftop exhaust fans, intake hoods, exhaust hoods and other roof penetrations that do not have ductwork below them to intercept dripping water.
- B. Drip pans shall be 22 gauge minimum cross-broken or reinforced sheet metal with 2" welded upturned lips.
- C. Pans shall extend 6" in all directions beyond the opening and shall have the top of the lip located 25% of the maximum throat dimension below the opening.
- D. Insulate interior of drip pan with 1" thick elastomeric foam insulation. Adhere foam to drip pan with standard foam adhesive.

2.4 DUCT ACCESS DOORS

- A. Fabricate per Fig. 7-2 and 7-3 of the SMACNA HVAC Duct Construction Standards and as indicated.
- B. Review locations prior to fabrication. Install access doors at fire dampers, smoke dampers, motorized dampers, fan bearings, filters, automatic controls, humidifiers, louvers, duct coils and other equipment requiring service inside the duct.
- C. Construction shall be suitable for the pressure class of the duct. Fabricate rigid, airtight, and close-fitting doors of materials identical to adjacent ductwork with sealing gaskets butt or piano hinges, and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- D. Access doors with sheet metal screw fasteners are not acceptable.
- E. Minimum size for access doors shall be 24" x 16" or full duct size, whichever is less.
- F. Provide duct access door in all horizontal return ductwork at 20 foot intervals per NFPA 90A.

- G. Fire Damper, Fire/Smoke Damper Access Provide quantity of access doors such that two hands can fit inside ductwork to manually reset fire dampers. For ducts larger than 12" x 12" , provide one access door. For ducts 12" x 12" and smaller, provide one access door on bottom and one on side.

2.5 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.6 REMOTE VOLUME CONTROL DEVICES - MANUAL

- A. Remote volume control balancing damper shall be supplied with either miter gears or right angle worm gears. Provide all damper shafts, gearboxes, couplings, U-joints, bearings, shafts, offsets, adapters, and adjustable concealed covers as required.
- B. When distances, angles, or offsets prevent installing solid rods, the mechanical cable control system may be utilized. Provide all damper shafts, rack and pinion gear operator, cables and sleeves, and adjustable ceiling mounting cups.
- C. Manufacturers:
 - 1. Young Regulator Company
 - 2. Metropolitan Air Technology

2.7 REMOTE VOLUME CONTROL DEVICES - ELECTRONIC

- A. Remote volume control balancing damper shall be supplied with 9V electronic actuator, minimum 25 foot plenum rated cable, wall plate with single gang backbox with one RJ11 port. Color of plate shall be white.
- B. Provide one handheld remote equipped with 9V power supply and 5 foot cable with RJ11 plug for connection to all dampers.
- C. Manufacturers:
 - 1. Greenheck EZ Balance RBD
 - 2. Young Regulator Company EBD

2.8 DUCTWORK ACCESSORY SEALANTS

- A. Ductwork accessory sealants and adhesives shall conform to Section 233100.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
 - 1. Install accessories in accordance with manufacturer's instructions.

2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Architect/Engineer.
3. Coordinate and install access doors provided by others.
4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".
5. Grease duct access doors shall be installed per approvals from manufacturer's ICC-ES Evaluation Report.
6. Provide duct test holes where indicated and as required for testing and balancing purposes.

B. Manual Volume Damper:

1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing. Use splitter dampers only where indicated.
2. Provide ceiling access doors for manual volume dampers. When manual volume dampers are located above an inaccessible ceiling and an access door cannot be installed, provide a remote-controlled volume control device for operation of the damper. Coordinate location with the Architect/Engineer.
3. Grease duct volume dampers shall be continuously welded to duct and/or hoods so that system is liquidtight.

C. Drain Pan:

1. Drain pans shall be installed per ASHRAE 62.1.
 - a. All drain pans shall be field tested under normal operating conditions to ensure proper drainage.
 - b. Field testing of drain pans is not required if units with factory installed drain pans have been certified (attested in writing) by the manufacturer for proper operation when installed as recommended.

END OF SECTION

SECTION 233416 - CENTRIFUGAL FANS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Airfoil Centrifugal Fans.
- B. Plenum Fans.
- C. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.

1.2 SUBMITTALS

- A. Submit shop drawings per Section 230500. Include data on all fans and accessories. Submit sound power levels for both fan inlet and outlet at rated capacity. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point.
- B. Submit operation and maintenance data. Include instructions for lubrication, motor and drive replacement, and spare parts list.
- C. Piezometer Flow Coefficients: Submittals for fans shall clearly indicate the size and associated flow coefficient for each fan included in the submittal as it relates to the piezometric airflow measuring system. Provide instructions indicating how the flow coefficient can be used in calculating fan airflow using the fan manufacturer-provided empirically derived formulas for calculating airflow. Include recommended differential pressure controller ΔP range inches w.g. based on scheduled maximum airflows.
- D. Submit certification that centrifugal fans, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:
 - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.3 EXTRA STOCK

- A. Provide one extra belt set for each fan unit.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

PART 2 - PRODUCTS

2.1 AIRFOIL CENTRIFUGAL FANS

- A. Fan Description: Double width, double inlet non-overloading centrifugal fan with airfoil blades.

- B. Construction:

1. Wheel: Heavy gauge steel plate housing, continuously welded, reinforced with inverted angles.
 - a. Die formed, airfoil blades with moisture relief holes in the trailing edge. Formed from a single sheet of steel and welded at the trailing edge. Continuously weld blades to rim and bolt wheel to hub.
 - b. Spun steel shroud.
 - c. Cast iron hub with oversize flange, keyed to shaft. ANSI 1040 or 1045 cold rolled solid steel shaft, accurately turned, ground and polished. Shaft shall be a constant diameter. Shaft shall be straightened before and after cutting the keyways to maintain a maximum TIR of 0.002".
 - d. Dynamically balanced. First shaft critical speed at least 20% above maximum AMCA class speed.
 - e. Fans shall operate with variable speed drives. Balance fans to operate at all speeds from zero RPM to full design speed. Motors shall be "variable frequency drive rated" when controlled by VFDs.
2. Housing: Deep contoured, spun or die formed inlet cones. 1-1/2" NPT drain with plug, continuously welded to lowest point of the scroll. Inspection door with waterproof gasketing. Flanged discharge collar drilled or punched at uniform intervals. Continuously weld flange to the fan housing.
3. Drive: V belt drive selected for 1.5 times the brake horsepower (shaft power). Adjustable pitch sheaves for 20 HP and below. Fixed sheaves above 20 HP. Contractor shall provide replacement sheaves and belts for final air balancing.
4. Support: Mount fan and motor on a common vibration isolation base.

C. Protection:

1. Screens: Inlet screens shall be minimum 8 gauge welded wire bolted to the fan for easy removal. Screens shall comply with OSHA opening size regulations. Attach screens directly to the fan.
2. Belt Guards: Install removable belt guard with shaft holes for tachometer. Construct from expanded metal or heavy gauge wire mesh with minimum 70% free area.

D. Bearings: Ball or roller bearings, grease packed or oil reservoir type. Bearing B-10 life of at least 200,000 hours at specified operating conditions. Extend lubrication lines beyond belt guards.

E. Piezometer Airflow Measuring: Provide fan with factory installed piezometer ports for monitoring the pressure difference between the fan inlet and the smallest diameter of the inlet cone. Ports shall be installed by the factory to ensure proper location of the taps to match how the fans were tested. Orifices shall be factory drilled in the smallest diameter of the inlet cone venturi. Flow tubes from each venturi sensor shall extend to a termination plate mounted on the fan housing. High pressure flow probes shall be factory mounted in the low velocity fan inlet. Flow probes from the high-pressure sensor shall extend to a termination plate mounted on the fan housing. Transducer for measuring differential pressure shall be provided by the Temperature Control Contractor (TCC). Include with fan submittal the empirically derived formulas developed by the fan manufacturer for each supply and return fan provided with the air handling unit, along with the recommended differential pressure transducer range.

F. Motor (as scheduled on drawings);

1. Induction: Furnish externally mounted open drip-proof, ball bearing motor, with adjustable mounts for belt tightening. Motor shall be minimum 1/3 HP. Motor and wheel supported by vibration isolators. Refer to motor specification for motor requirements.

G. Manufacturers:

1. Aerovent
2. Twin City
3. Greenheck
4. Chicago Blower
5. Cook
6. Peerless
7. PennBarry Blower
8. FloAire

2.2 AIRFOIL PLENUM FANS - DIRECT DRIVE

A. Fan Description: Direct Drive, single width, single inlet non-overloading centrifugal fan with airfoil blades.

B. Construction:

1. Wheel:

- a. Die formed, airfoil blades with moisture relief holes in the trailing edge. Formed from a single sheet of steel and welded at the trailing edge. Continuously weld blades to rim and bolt wheel to hub.
- b. ANSI 1040 or 1045 cold rolled solid steel shaft, accurately turned, ground and polished. Shaft shall be a constant diameter. Wheel shall be attached to the motor shaft using a taper lock bushing. Shaft shall be straightened before and after cutting the keyways to maintain a maximum TIR of 0.002".
- c. Dynamically balanced. First shaft critical speed at least 20% above maximum AMCA class speed.

2. Housing: Deep contoured, spun or die-formed inlet cone.

3. Drive: Direct drive. Fans shall operate with variable speed drives. Balance fans to operate at all speeds from zero RPM to full design speed. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to motor specification.

4. Support: Mount fan and motor on a common vibration isolation base.

C. Bearings: Ball or roller bearings, grease packed or oil reservoir type. Bearing B-10 life of at least 200,000 hours at specified operating conditions. Extend lubrication lines beyond belt guards.

D. Protection:

1. Screens: Provide inlet screen. Inlet screen shall be bolted to the fan for easy removal. Screens shall comply with OSHA opening size regulations.
2. Provide safety screen enclosure around fan wheel. Enclosure shall be expanded metal screen bolted to heavy steel frame.

E. Piezometer Airflow Measuring: Provide fan with factory installed piezometer ports for monitoring the pressure difference between the fan inlet and the smallest diameter of the inlet cone. Ports shall be installed by the factory to ensure proper location of the taps to match how the fans were tested. Orifices shall be factory drilled in the smallest diameter of the inlet cone venturi. Flow tubes from each venturi sensor shall extend to a termination plate mounted on the fan housing. High pressure flow probes shall be factory mounted in the low velocity fan inlet. Flow probes from the high-pressure sensor shall extend to a termination plate mounted on the fan housing. Provide piezometer on each fan in an array. Transducer for measuring differential pressure shall be provided by the Temperature Control Contractor (TCC). Include with fan submittal the empirically derived formulas developed by the fan manufacturer for each supply and return fan provided with the air handling unit, along with the recommended differential pressure transducer range.

F. Motor (as scheduled on drawings):

1. Induction: Furnish permanently lubricated sealed ball type motor and drive shaft bearings. Motor and wheel supported by vibration isolators.
 - a. Disconnect as scheduled on drawings.

2. Electronically Commutated Motor (ECM): Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall include integral surge protection. Motor shall be pre-wired for specific voltage and phase. Motor frame shall be NEMA 48. All EC motors shall be a minimum of 85% efficient at all speeds. Provide motor with onboard motor control module. Motor speed shall be limited to provide electronic overcurrent protection. Provide non-fused, with thermal overload protection, factory mounted and wired disconnect switch mounted inside fan housing. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed. Operational mode shall be as follows:

- a. ECM set for constant CFM.

G. Acceptable Manufacturers:

1. Aerovent
2. Twin City
3. Greenheck
4. Chicago Blower
5. Cook
6. Peerless
7. PennBarry Blower
8. FloAire

2.3 FUME EXHAUST FAN (300-20,000 cfm AND 0-8" STATIC PRESSURE)

A. Fan Description: Single inlet, single width. backward inclined wheel, with factory stack extension, factory mounted inlet box, mounted to a single curb cab. Suitable for exhaust streams from -40F to +200F and ambient temperatures from -40F to +120F.

B. Construction:

1. Wheel: Backward inclined airfoil wheels suitable for handling fumes and gases at minimum noise levels. Blades shall be continuously welded to the backplate and inlet shroud. Wheel hub shall be keyed and securely attached to the motor shaft. AMCA Type B spark resistant construction including aluminum wheel and non-ferrous shaft closure plate.
2. Housing: 14 gauge minimum inlet collar, flanged outlet connection. Heavy gauge steel all welded construction (14 gauge min. sides), adaptable to any of 8 discharge positions in the field. 1" drain connections in housing bottoms. Lever operated access door near top of scroll for wheel inspection.
3. Stack Extension: Integral, self-supported stack for a minimum of 10ft discharge above the roof.
4. Drive: Arrangement 4 direct drive.
5. Support: Lifting eyes. Steel or aluminum mounting frame with baked enamel finish.
6. Coating: All surfaces in contact with the airstream shall be cleaned with solvent equal to Heresite 330 and given three 2 mil minimum thickness coats of air-dried phenolic equal to Heresite VR-500. Coat entire face of all flanges and entire length of inlet collars on both sides.

C. Protection:

1. Belt guards with tachometer knockouts on indoor fans. Removable weather covers on outdoor fans.

D. Motor (as scheduled on the drawings):

1. Induction: Furnish externally mounted open drip-proof, ball bearing motor. Refer to motor specification for motor requirements.
 - a. Disconnect as scheduled on drawings.
2. Electronically Commutated Motor (ECM): Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall include integral surge protection. Motor shall be pre-wired for specific voltage and phase. Motor frame shall be NEMA 48. All EC motors shall be a minimum of 85% efficient at all speeds. Provide motor with onboard motor control module. Motor speed shall be limited to provide electronic overcurrent protection. Provide non-fused, with thermal overload protection, factory mounted and wired disconnect switch mounted inside fan housing. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed. Operational mode shall be as follows:
 - a. ECM set for constant CFM.

E. Roof Mounting Curb: Minimum 12" inches (mm), minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

F. Curb Cap and Inlet Box: Fully welded seams and corners, gasketed access door, and under curb duct drop with matching flange and field duct connection.

G. Bearings: Regreasable bearings rated for 100,000 hour B-10 life at specified operating point.

H. Products:

1. Aerovent 'BI' or 'BIA'
2. Twin City 'BC'
3. Cook 'CA'

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Prime all fan parts after cleaning, but prior to assembly. Apply a second finish coat to all exterior surfaces and all accessible interior surfaces after assembly. Apply rust preventative coating to shafts.

2. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
3. Install flexible connections between fan and ductwork. Install metal bands of connectors parallel with minimum 1" flex between ductwork and fan while running.
4. Provide safety screen where inlet or outlet is exposed. Screens shall meet OSHA regulations for size of openings.

B. Fume Exhaust Fan:

1. Each fume exhaust fan shall have a 3/8" diameter hole drilled in one of its base rails for electrical grounding. Scrape away paint near the hole for good grounding.

END OF SECTION

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Single Duct Variable Air Volume Terminal Box.
- B. Dual Duct Variable Air Volume Terminal Box.
- C. Fan Powered Variable Air Volume Terminal Box.

1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 230500.
- B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.
- C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate airflow, static pressure, and NC designation.
- D. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch WG.
- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Submit manufacturer's installation instructions.
- G. Submit certification that all air terminal units, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:
 - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.3 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.
- C. Include directions for resetting constant volume regulators.

PART 2 - PRODUCTS

2.1 ACOUSTICAL CONSIDERATIONS (THIS APPLIES TO ALL UNITS)

- A. All units shall have noise data certified in accordance with AHRI Standard 885-98 with 5/8" 20-lb. density mineral fiber ceiling tile and shall not produce space noise values over NC-35 due to radiated and airborne noise combined. Acoustical considerations shall take priority over sizes noted in schedule. It is the manufacturer's responsibility to increase inlet size to meet acoustic levels scheduled.

2.2 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL BOX

- A. Casing: Minimum 22 gauge galvanized steel.
 - 1. Insulation: Insulation shall be UL listed and meet NFPA 90A requirements. Fully insulated with:
 - a. Minimum 1/2", minimum 1-1/2 pound density fiberglass insulation.
 - b. Usage: All supply air systems.
 - 2. Non-insulated.
 - a. Usage: Return air system, exhaust air system.
- B. Damper Blade: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.
- C. Inlet Flow Sensor: Provide "cross" or "ring" style velocity and static sensor at inlet to box for use by unit controller.
 - 1. Boxed located in a Return and Exhaust system shall include removable airflow sensors to allow cleaning.
- D. Damper Operators: Furnish all mounting brackets, relays, and linkages. Damper operator shall be provided as follows:

1. Electronic: Provided by the manufacturer and installed in the factory. Operator shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).
- E. Electronic Volume Regulator/Controller: Set boxes for maximum and minimum settings shown on the drawings. Electronic volume regulator/controller shall be provided as follows:
 1. Provided by the manufacturer and installed in the factory.
- F. Hot Water Coils: Copper tubes, aluminum fins, minimum 0.016" wall thickness, leak tested at 300 psig. Air pressure drop shall not exceed scheduled value. Provide access door or removable panel for access to the upstream side of the heating coil. Capacity shall be as scheduled on the drawings. Hot water control valve shall be by the TCC.
- G. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.
- H. Refer to control diagrams and notes on control drawings for complete sequence of control.
- I. Manufacturers:
 1. Carrier
 2. Titus
 3. Trane
 4. Krueger
 5. Carnes
 6. E.H. Price
 7. Tuttle & Bailey
 8. Nailor
 9. Enviro-Tec
 10. Johnson Controls Inc.
 11. Metalaire.
 12. Anemostat.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Maintain minimum working clear space for all electrical connections in accordance with NFPA 70, National Electrical Code.

- C. Provide ceiling access doors or locate units above easily removable ceiling components.
- D. Support units individually from structure. Do not support from adjacent ductwork.
- E. Where boxes are located adjacent to a wall or joist, the damper motors and control valves shall be located on the side of the box away from the wall or joist to permit easy access.
- F. Comb fins on coils to repair bent fins.
- G. Insulate terminal air box hydronic reheat coils to prevent condensation. Tape insulation tight to box. Do not insulate or interfere with actuator, access panel and control panel.

3.2 ADJUSTING

- A. All boxes shall be set to the cfm shown on the drawings. TCC shall be responsible to field recalibrate all boxes that are not set correctly.

END OF SECTION

SECTION 233700 - AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Grilles And Registers.
- B. Architectural Square Panel Diffusers.
- C. Laminar Flow Diffusers.
- D. Linear Diffusers.
- E. Linear Diffuser Supply Plenum.

1.2 QUALITY ASSURANCE

- A. Test and rate performance of air inlets and outlets per ASHRAE 70.
- B. Test and rate performance of louvers per AMCA 500L-99.
- C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 REFERENCES

- A. AMCA 500-L-12 - Laboratory Methods of Testing Louvers for Rating.
- B. ANSI/ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Inlets and Outlets.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ASHRAE 170 (latest published edition) - Ventilation of Health Care Facilities.
- E. SMACNA - Duct Construction Standards.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 230500.
- B. Submit schedule of inlets and outlets indicating type, size, location, application, and noise level.
- C. Review requirements of inlets and outlets as to size, finish, and type of mounting prior to submitting product data and schedules of inlets and outlets.

- D. Submit manufacturer's installation instructions.
- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Where color selection by Architect is necessary, provide physical color chips for color selection directly to the Architect. Electronic color charts are not acceptable.

1.5 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.
- B. Conform to ASHRAE 90.1.

1.6 EXTRA STOCK

- A. Provide clean filters in all filter return grilles at time of installation.
- B. Provide one additional set of replacement filters for all filter return grilles. Deliver to Owner at job site.

PART 2 - PRODUCTS

2.1 AIR TERMINALS - GRILLES AND REGISTERS

- A. Reference to a grille means an air supply, exhaust or transfer device without a damper.
- B. Reference to a register means an air supply, exhaust or transfer device with a damper.
- C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.
- D. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents shall be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.
- E. The capacity and size of the unit shall be as shown on the drawings.
- F. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect. .
- G. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.
- H. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.
- I. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.

- J. Where specified to serve registers, provide opposed blade volume dampers operable from the face of the register.
- K. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.
- L. Manufacturers:
 - 1. Tuttle & Bailey
 - 2. Titus
 - 3. Price
 - 4. Nailor
 - 5. Carnes
 - 6. Metalaire
 - 7. Krueger
 - 8. Anemostat
 - 9. Raymon Donco

2.2 AIR TERMINALS - ARCHITECTURAL SQUARE PANEL DIFFUSERS

- A. Reference to a diffuser means an air supply device, ceiling mounted, that shall diffuse air uniformly throughout the conditioned space.
- B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule. Flat-oval inlets are not acceptable for connection to flexible ducts.
- C. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents should be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.
- D. The capacity and size of the unit shall be as shown on the drawings.
- E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect. .
- F. Diffusers shall be architectural solid square panel and flush with ceiling.
- G. The exposed surface shall be smooth, flat and free of visible fasteners. The face panel shall be 22 gauge steel with a rolled edge or shall be 18 gauge with a smooth ground, uniform edge.
- H. The back pan shall be one piece 22 gauge stamped and shall include an integral inlet. (Welded inlets and corner joints are not acceptable).
- I. Diffusers with a 24x24 back pan shall have a minimum 18x18 face panel size. Diffusers with a 12x12 back pan shall have a minimum 9x9 face panel size.
- J. The face panel shall be mechanically fastened to the back panel with steel components. (Plastic fasteners are not acceptable.)

K. Manufacturers:

1. Tuttle & Bailey
2. Titus
3. Price
4. Nailor
5. Carnes
6. Metalaire
7. Krueger
8. Anemostat
9. Raymon Donco

2.3 AIR TERMINALS - LAMINAR FLOW DIFFUSERS

- A. Perforated panel diffuser to be laminar flow type, aluminum construction with manufacturer's standard white baked enamel or acrylic finish. Diffuser shall deliver air to the space with zero aspiration at the face of the perforated plate. Velocities in the plane of the perforated plate shall vary no more than 10%.
- B. With a design temperature difference of 10F, average velocity at four feet below the diffuser face shall not exceed 54 fpm. Static pressure at 20 cfm per square foot face velocity shall not exceed 0.05 water column. NC level shall not exceed 27.
- C. Plate shall be retained to the module frame through the use of quarter-turn fasteners. Safety retainers of stainless steel cable or chain shall be provided to prevent accidental dropping of plate. Distribution plate shall be installed in aluminum mounting frame.
- D. Fill-in panels identical in appearance to the active air distribution modules shall be furnished where shown on the plans.
- E. Filters: MERV 17 HEPA 3" thick filter. Filter efficiency shall be based on ANSI/UL 586. Maximum pressure drop 0.25in.w.c. at 60FPM. Filters shall not be installed until air balancing occurs. Provide two (2) sets of filters. Install one set immediately prior to balancing. Turn over second set to the Owner at completion.
- F. Provide integral filter locating indicator light in frame face.
- G. Provide integral aerosol injection port with dispersion tube and static pressure port for field test and certification.
- H. Manufacturer:
 1. Precision Air Products Co. PAT
 2. Titus
 3. Tuttle & Bailey
 4. Krueger
 5. Metalaire
 6. Nailor

2.4 AIR TERMINALS - LINEAR DIFFUSERS

A. Plenum Slot Diffusers (Lay-In):

1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
2. The capacity and size of the unit shall be as shown on the drawings.
3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect. .
4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
5. Linear diffusers and mounting frames shall be furnished as one piece up to 5' in length.
6. Diffusers shall be furnished with factory installed adjustable "ice tong" style pattern deflectors capable of providing 180-degree pattern adjustment.
7. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
8. Number and width of slots shall be as shown on the drawings.
9. Provide integral insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum specification section for details.
10. Manufacturers:
 - a. Tuttle & Bailey ITPS
 - b. Carnes DA
 - c. Price TBD
 - d. Krueger PTBS
 - e. Nailor 5800
 - f. Titus TBD
 - g. Metalaire
 - h. Anemostat API
 - i. Raymon Donco SAT
11. Linear diffusers for fire-rated ceiling shall be UL labeled with a non-adjustable air pattern. Airflow direction shall be as shown on the drawings.
12. Manufacturers for fire-rated diffusers:
 - a. Kees FRK-UL
 - b. Titus TBD-FR
 - c. Krueger PFTBS
 - d. Price TBD2-FR
 - e. Raymon Donco 2000FR
 - f. Metalaire

2.5 AIR TERMINALS - LINEAR DIFFUSER SUPPLY PLENUM

- A. Linear diffusers shall be provided with field fabricated or prefabricated supply plenums. Plenum shall be a minimum of 2-1/2" wider than total slot width, minimum length of slot, and minimum height of 10". Plenums with end fed duct connections shall not exceed 8' in length. The cross sectional area of the plenum shall be designed for a maximum velocity of 500 fpm and the aspect ratio shall be limited to a width-to-height ratio of less than 1.5. Plenums with side outlets shall be designed for a maximum velocity of 600 fpm and inlet ducts to plenum shall be spaced 5' on center maximum. Inlet ducts to plenums shall have a maximum velocity of 900 fpm. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
- B. Plenum shall be constructed with 24 gauge galvanized steel and shall have side inlets unless shown otherwise on the drawings. Refer to Ductwork Application Schedule in Section 233100 for insulation requirements.
- C. End caps and required accessories shall be integral with the plenum or furnished and installed by the Mechanical Contractor.
- D. A manual volume damper shall be furnished and installed by the Mechanical Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings
- E. Prefabricated plenums shall be by the same manufacturer as the linear diffuser or Kees Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
 - 1. Install items in accordance with manufacturers' instructions.
 - 2. Install seismic restraints according to SMACNA's "Kitchen Equipment Fabrication Guidelines, Appendix 1, Guidelines for Seismic Restraints for Kitchen Equipment".
 - 3. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
 - 4. Install diffusers to ductwork with air tight connections.
 - 5. Flexible ducts shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required.
 - 6. Supply air diffusers in operating rooms (Class B and C surgery) shall be opened and cleaned before the space is used.
 - 7. Supply grille and register blades shall be aimed in the field to provide adequate air distribution in the space. All return grilles and registers blades shall be oriented to minimize sight distance beyond installed device.

B. Volume Damper:

1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.

C. Maintaining Duct Cleanliness:

1. When grilles, registers, and diffusers are installed, Contractor shall prevent construction dust, dirt, and debris from entering ductwork as required by Section 230500.

END OF SECTION

SECTION 237200 - ENERGY RECOVERY DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Energy Recovery Wheels.

1.2 QUALITY ASSURANCE

- A. Sound Ratings: Tested to AMCA 300.
- B. Fabrication: Conform to AMCA 99 and AHRI 430.
- C. Enthalpy/Heat Recovery Wheels and Fixed Plate Energy Exchange Element: Effectiveness values shall be tested in accordance with ASHRAE 84, be AHRI certified to Standard 1060, and bear the AHRI Certification symbol for AHRI Air-to-Air Energy Recovery Ventilation Equipment Certification program based on AHRI 1060.
- D. Unit shall bear a UL or ETL label of approval.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 230500.
- B. Energy transfer performance shall be clearly documented through a certification program conducted in accordance with ASHRAE 84 and AHRI 1060 standards. Submit enthalpy wheel AHRI 1060 compliance certification with reference number.
- C. Indicate ratings, enthalpy wheel performance, pressure drop, outdoor air correction factor (OACF), exhaust air transfer rate (EATR), motor electrical characteristics, gauges, material finishes, assembly, unit dimensions, weight, required clearances, construction details, and field connection details.
- D. Submit manufacturer's installation instructions.
- E. Any exceptions to the specifications must be clearly noted. Contractor is responsible for any additional expenses that may occur due to any exception made.
- F. Submit operation and maintenance data. Include instructions for lubrication, belt replacement, motor and drive replacement, and spare parts lists.
- G. Submit static pressure calculations showing total pressure drops.
- H. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- I. Submit certification that energy recovery devices, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 EXTRA STOCK

- A. Provide one extra set of energy recovery wheel drive belts. Deliver to Owner at job site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.6 WARRANTY

- A. Provide manufacturer's 10-year parts and labor warranty on fixed plate energy exchange element against defects in material and workmanship.
- B. Provide manufacturer's 18-month parts and labor warranty on the enthalpy wheel against defects in material and workmanship.

PART 2 - PRODUCTS

2.1 ENERGY RECOVERY WHEEL

- A. Enthalpy Wheel:
 1. Wheel shall provide both sensible and latent heat recovery. Sensible and latent effectiveness shall meet or exceed scheduled values.
 2. The media shall be constructed of lightweight polymer and shall not degrade or require additional coatings over time. The rotor media shall be continuously wound with one flat and one structured layer that is coated with a non-migrating, permanently bonded molecular sieve or silica gel desiccant, specifically developed for the selective transfer of water vapor. Wheels greater than 25" in diameter shall have multiple segments that can be individually removed. Surfaces sprayed, dip coated, or desiccants that must be reapplied over time are not acceptable. Wheels with desiccant applied after wheel formation are not acceptable.

3. Energy recovery effectiveness values shall be tested in accordance with ASHRAE 84 and be AHRI certified to Standard 1060 and bear the AHRI Certification symbol for AHRI Air-to-Air Energy Recovery Ventilation Equipment Certification program based on AHRI 1060.
4. Seal: Enthalpy wheel cassette shall be complete with face seal and perimeter seal to prevent cross leakage between the two airstreams. Both seals shall be non-wearable to minimize leakage.
5. Casing: Rotor casing shall limit the deflection of the rotor due to air pressure differential to less than 1/16 inch at design differential pressure. Framing shall be corrosion resistant. Support rotor from bearings that can be maintained or replaced without removal of the rotor from its casing or the media from its spoke system. Wheel bearings shall be selected to provide an L-10 life more than 200,000 hours.
6. Frame: The rotor frame shall be a hub, spoke and rim system that provides the structural integrity required at design pressure differentials.
7. Drive: Rotor shall be driven from belt system and electric motor. Wheel shall be perimeter driven. Provide motor with internal overload protection.
8. Frost Control: Bypass dampers shall be controlled to bypass outdoor air around the wheel to avoid frosting conditions on the wheel. Outdoor air preheat coil shall be installed to maintain a minimum outdoor air temperature to avoid frosting conditions.
9. The media shall be fluted, corrugated in design to minimize the leakage of the exhaust air to the supply air through the media. The rotor media shall be coated with a non-migrating desiccant specifically developed for the selective transfer of water vapor. Silica gel and oxidized aluminum are not acceptable. All media surfaces shall be coated with polymerdesiccant prior to being formed into the fluted media structure. Surfaces sprayed, dip coated, or desiccants that must be reapplied over time are not acceptable. Impregnated desiccants in non-metallic substrates, such as papersynthetic plastic or glass fiber, will not be acceptable. Wheels with desiccant applied after wheel formation are not acceptable. Wheels shall be treated for corrosion resistance to water moisture.
10. Energy recovery effectiveness values shall be tested in accordance with ASHRAE 84 and be AHRI certified to Standard 1060 and bear the AHRI Certification symbol for AHRI Air-to-Air Energy Recovery Ventilation Equipment Certification program based on AHRI 1060.
11. Seal: Enthalpy wheel Heat wheel cassette shall be complete with face seal and perimeter seal to prevent cross leakage between the two airstreams. Both seals shall be non-wearable to minimize leakage up to specified differential pressure. Seals shall be adjustable.
12. Casing: Rotor casing shall limit the deflection of the rotor due to air pressure differential to less than 1/16 inch at design differential pressure. Framing shall be galvanized steel, aluminum, or other metal treated to be corrosion resistant to water moisture. Any exposed metal that is not corrosion resistant to water moisture shall be painted with primer and corrosion-resistant paint. Support rotor from bearings selected to support the rotating weight of the wheel. The bearings shall be maintained or replaced without removal of the rotor from its casing or the media from its spoke system.
13. Frame: The rotor frame shall be an industrial spoke system that provides the structural integrity required at design pressure differentials. Wheel construction shall allow for post-fabrication wheel alignment.

14. Drive: Rotor shall be driven from belt system and electric motor. Wheel shall be perimeter driven with pulley sized properly for wheel size and rotation speed. Rotor belt shall have no field adjustments required (0% stretch after initial tension). Provide motor with internal overload protection.
15. Seal: Enthalpy wheel Heat wheel cassette shall be complete with face seal and perimeter seal to prevent cross leakage between the two airstreams. Both seals shall be non-contact, multi-pass seals to minimize leakage up to specified differential pressure. Seals shall be adjustable.
16. Flame and Smoke Test and Rating: Wheel shall have a flame-spread rating of 25 or less and a smoke-developed rating of 50 or less as tested in accordance with ASTM E84.
17. Wheel Construction: Wheels of more than 60 inches in diameter shall be of segmented construction, with pie-shaped sections bolted to the hub to form the wheel. Each joint shall be sealed to prevent air from bypassing the element.
 - a. For segmented wheels, the wheel manufacturer shall provide field supervision and instruction of the assembly of the first wheel to be assembled at the job site. The installing contractor shall assemble the remaining wheels.
18. Wheel flatness shall be within $\pm 1/32$ inch and wheel runout shall be within $\pm 1/8$ inch measured with wheel rotating and no air pressure applied. Cassette frame shall allow for adjustment of wheel to run true and be centered within the frame.
19. Casing: Rotor casing shall limit the deflection of the rotor due to air pressure differential to less than $1/32$ inch more than the runout at design air pressure differential. Framing shall be galvanized steel, aluminum, or other metal treated to be corrosion resistant to water moisture. Any exposed metal that is not corrosion resistant to water moisture shall be painted with primer and corrosion-resistant paint. Support rotor from tapered roller bearings selected to support the rotating weight of the wheel with a minimum safety factor of 4. The bearings shall be maintained or replaced without removal of the rotor from its casing or the media from its spoke system.
20. Frame: The rotor frame shall be industrial spoke system that provides the structural integrity required at design pressure differentials. Wheel construction shall allow for post-fabrication wheel alignment.
21. Shaft: Shaft shall be machined to provide a shoulder against the bearings for a positive locked position to eliminate any lateral movement of the rotor due to set screw failure or shaft wear.
22. Drive: Rotor shall be driven from belt system and electric motor. Wheel shall be perimeter driven with pulley sized properly for wheel size and rotation speed. Rotor belt shall have no field adjustments required (0% stretch after initial tension). Provide motor with internal overload protection.

B. Media Cleaning:

1. The media shall be cleanable with hot water or light detergent, low pressure steam (less than 5 psi), vacuum, or compressed air (less than 80 psi without degrading the latent recovery. Dry particles up to 800 microns shall freely pass through the media. Enthalpy wheel shall be self-cleaning by two counter flow airstreams.

C. Dampers:

1. Provide dampers as needed to allow for 100% airflow bypass around the wheel to allow for economizer.
2. Refer to drawings for size and location.
3. Provided by unit manufacturer. Refer to Section 230900 for requirements.

D. Manufacturers:

1. Innergy Tech
2. Novel Aire
3. DRI
4. Seibu Giken (SG America)

PART 3 - Enventus or Xetex/AIRotorEXECUTION

3.1 INSTALLATION

- A. Install per manufacturer's instructions.
- B. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan(s) have been test run under observation.
- C. P-traps must be installed for all drain pans.

END OF SECTION

SECTION 237413 - ROOFTOP MODULAR AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Modular Outdoor Air Handling Units.

1.2 QUALITY ASSURANCE

- A. AHU Unit: Manufacturer specializing in design and manufacturing of the products specified in this section with a minimum of five years' experience.
- B. Fabrication: Conform to AMCA 99 and AHRI 430.
- C. Fan Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- D. Sound Ratings: Tested to AMCA 300.
- E. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.
- F. Air Coils: Certify capacities, pressure drops, and selection procedures per AHRI 410.
- G. Electrical control wiring shall be in accordance with NEC codes and ETL requirements.
- H. Unit shall contain only UL listed components.
- I. Conform to ASHRAE 90.1.
- J. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 230500. Indicate ratings, fan performance, motor electrical characteristics, gauges, material finishes, assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

1. Product Data

- a. Include data on all fans and accessories. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point.

- b. Select fans using external static pressure noted in the schedule. Manufacturer responsible for calculation of internal static pressure. Manufacturer shall include an allowance for clean filters in the internal static pressure. An allowance for the difference between dirty filters and clean filters is included in the external static. Submit static pressure calculations showing total pressure drops, including tabulated internal pressure drops and specified external static pressure drops
 - c. Submit sound power level data for both fan outlet and casing radiation at rated capacity.
 - d. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions
 - e. Submit manufacturer's data showing that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.
 - f. Provide a copy of data of filter media, filter performance data, filter assembly, and filter frames with unit submittal for reference only.
- B. Submit manufacturer's installation instructions.
- C. All base bid pricing shall be based on the drawings, schedules and this specification
 - 1. If a manufacturer requests to deviate from the requirements described herein, the Manufacturer and/or Contractor may list voluntary add or deduct prices on the bid form. These voluntary prices will not be used in determining the low bidder.
 - 2. All voluntary adds or deducts shall be discussed and agreed to by the Owner and Architect/Engineer prior to the award of the air handling unit bid and before the submittal process begins.
- D. Any exceptions to the specifications must be clearly noted to the Architect/Engineer prior to acceptance. Contractor is responsible for all expenses due to exceptions.
- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.
- G. Piezometer Flow Coefficients: Submittals for fans shall clearly indicate the size and associated flow coefficient for each fan included in the submittal as it relates to the piezometric airflow measuring system. Provide instructions indicating how the flow coefficient can be used in calculating fan airflow using the fan manufacturer provided empirically derived formulas for calculating airflow. Include recommended differential pressure controller ΔP range inches w.g. based on scheduled maximum airflows.
- H. Submit certification that modular air handling units, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:
 - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

- a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- 1.4 EXTRA STOCK
- A. Provide clean filters in all units at time of installation.
 - B. Provide clean filters in all units at project final completion after all interior finishes are complete.
 - C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to site with protective coverings in-place. Loose shipped items must be in factory-provided protective coverings, with factory-installed shipping skids and lifting lugs.
 - B. Store unit in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- 1.6 WARRANTY
- A. Provide a manufacturer's 1-year parts and labor warranty against defects in material and workmanship.
- 1.7 GENERAL DESCRIPTION
- A. Unit Location:
 1. The air handling unit (AHU-#) is a variable air volume modular unit, located on the roof.
 2. The unit will be set on a roof curb by the Contractor.
 - B. Building Type:
 1. The building is a steel structure with a cast-in-place concrete floor system on steel bar joists. (AHU-1)
 - C. Unit Description:
 1. The unit shall contain all the components described in these specifications and shown on the drawings and schedules.
 2. Refer to air handling unit drawings and schedules for additional information

PART 2 - PRODUCTS

2.1 MODULAR OUTDOOR AIR HANDLING UNITS

A. Manufacturers:

1. Trane - Performance Climate Changer
2. Daikin - Skyline
3. Ventrol - ITF Outdoor Unit
4. Temtrol - Series ITF

B. Unit Casing:

1. Minimum 18 gauge G90 galvanized steel exterior panels reinforced and braced with galvanized steel framework.
2. Removable access panels for coil and fan removal.
3. Unit shall be double wall constructed and insulated in all sections. Exterior wall shall be minimum 18 gauge galvanized steel. Interior wall shall be minimum 20 gauge solid galvanized steel. Cover all portions of the interior of the unit exposed to the airstream with steel to allow cleaning and prevent fiberglass erosion into the airstream. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. If casing sections are not provided by the unit manufacturer with double wall construction, the Contractor is responsible for covering exposed insulation with galvanized sheet metal. The minimum R-value of the panel assemblies shall be 8. Roof and wall panels downstream of cooling coil shall include thermal break design with no through metal penetrations.
4. Install a stainless steel drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance 1/2 of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
5. Units shall be draw-thru or blow-thru as noted on the drawings and shall not exceed the overall dimensions.
6. Provide unit base to allow unit to set on top of rooftop curb. Seal entire length and width under base to create a weather tight seal between the curb and the unit.
7. The external surface of the unit shall be factory painted to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours. Unit casing shall be prepared and coated with a minimum of 1.5 mil enamel finish. Color selected by Architect.
8. The unit's roof shall be double wall constructed. The inner roof shall be installed in such a manner to prevent air bypass between internal components. The outer roof shall be sloped a minimum of 0.25" per foot either from one side of the unit to the other, or from the center to the sides of the unit. All seams shall be gasketed and capped to prevent water infiltration. The roof assembly shall have a drip seal that overhangs all the walls of the unit.
9. Provide unit with a full length, continuous, base rail channel. Base rail channels shall be formed of a minimum 12 gauge galvanized steel. Support all major components from base rail.

C. Doors:

1. Unit doors shall be double wall and insulated with the same materials used in the surrounding unit walls. Doors downstream of cooling coil shall include thermal break design with no through metal penetrations.
2. Door shall have a protective flange to shield gasket from exposure. Door frame shall be mounted on raised door frame and shall channel water away from gasket.
3. Doors shall contain a continuous neoprene bulb type gasket.
4. Each door shall contain a double pane tempered, reinforced or safety glass window.
5. Each door shall have a minimum of two (2) high compression type latches, operable from both sides.
6. Provide minimum 12" x 18" hinged access doors on both sides of the fan housing.

D. Access Sections:

1. Provide access sections as shown on the drawings between unit sections.

E. Air Blender:

1. Shall be of rotary mixing design employing radial blades
2. Shall be completely fixed devices with no moving parts.
3. Shall be provided with proper distances up and downstream such that the mixer is capable of providing a minimum mixing effectiveness of 75% and $\pm 6F$ standard deviation when mixing 50% outside air with 50% return air at 50F (10C) inlet temperature differential.
4. Shall be sized for maximum velocities between 1,000 FPM and 1,500 FPM.

F. Fan:

1. Direct Drive Single Width, Single Inlet Plenum Multi-fan Array with Airfoil Blades:
 - a. Fan RPM shall not exceed 110% of scheduled value with the scheduled wheel type.
 - b. Statically and dynamically balanced.
 - c. Fans shall have permanently lubricated ball bearings.
 - d. Provide extended lubrication lines for all bearings to an easily accessible location.
 - e. Factory balanced fans will be used with variable speed controls to operate at all speeds up to the design speed.
 - f. Fan(s) shall have internal spring isolators.
 - g. Multiple fan arrays shall be provided with gravity backdraft dampers on each fan inlet.

- h. Piezometer Air Flow Measuring: Provide fan with factory installed piezometer ports for monitoring the pressure difference between the fan inlet and the smallest diameter of the inlet cone. Ports shall be installed by the factory to ensure proper location of the taps to match how the fans were tested. Orifices shall be factory drilled in the smallest diameter of the inlet cone venturi. Flow tubes from each venturi sensor shall extend to a termination plate mounted on the fan housing. High pressure flow probes shall be factory mounted in the low velocity fan inlet. Flow probes from the high-pressure sensor shall extend to a termination plate mounted on the fan housing. Provide piezometer on each fan in an array. Transducer for measuring differential pressure shall be provided by the Temperature Control Contractor (TCC). Include with fan submittal the empirically derived formulas developed by the fan manufacturer for each supply and return fan provided with the air handling unit, along with the recommended differential pressure transducer range.

G. Motors and Drives:

1. AC Induction Motors:

- a. Motors shall have slide rails, adjusting screws, anchor bolts and bedplates.
- b. Motor mounting bracket shall be adjustable to allow tightening of belts.
- c. Motors shall be open drip-proof or TEFC type with grease lubricated bearings.
- d. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 230513.
- e. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. On units over 20 HP, use fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.

H. No equipment shall be selected or operate above 90% of its motor nameplate rating. Variable Frequency Drives:

- 1. Provided and installed by unit manufacturer. Refer to Section 262923 for requirements.

I. Multi-Zone Units:

- 1. Equip with zone dampers as shown on drawings.
- 2. Maximum 1700 fpm through either hot or cold opening when one damper is closed.
- 3. Units shall be blow-through design with heating and cooling coils.
- 4. Unit casing shall have access panels for servicing of all hot and cold zone dampers.
- 5. The unit manufacturer shall provide zone dampers. Refer to Section 230900 for damper requirements. If the unit manufacturer is unable to meet the requirements listed in Section 230900, the unit manufacturer shall provide dampers from an outside source that meet these specifications.
- 6. Extend damper rods outside of the casing to allow attachment of damper motors on the top or bottom of the casing.

J. Coils

1. Hot Water Coils:

- a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
- b. Suitable for continuous operation at 200 psi. Maximum air velocity of 1000 fpm.
- c. Galvanized steel casing. Coil headers and U-bends shall not be exposed.
- d. AHRI rated with 0.0005 tube side fouling factor.
- e. Size coils sized based on EWT, EAT, gpm and cfm as scheduled. LAT shall be at least as high as scheduled. APD and WPD shall not exceed scheduled values.
- f. Maximum 144 fins per foot.
- g. Turbulators are not permitted unless tube velocities are below 2 FPS at design flow or noted otherwise. Turbulators shall be allowed if removable headers are specified.
- h. Coils shall have drain and vent connections at supply and return headers with valves. Extend valving outside of the unit casing.
- i. Install coils level to allow drainage.
- j. Minimum 0.024" tube wall thickness.
- k. Manufacturers:
 - 1) Trane
 - 2) York
 - 3) Daikin
 - 4) Carrier
 - 5) Marlo Heatcraft
 - 6) or American Air Filter.

2. Chilled Water Coils:

- a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
- b. Stainless steel casing. Coil headers and U-bends shall not be exposed.
- c. Maximum air velocity of 500 fpm.
- d. AHRI rated with 0.0005 tube side fouling factor.
- e. Coils shall be sized based on EWT, EAT, gpm and cfm as scheduled. The leaving DB, leaving WB, APD and WPD shall not exceed the scheduled values.
- f. Maximum 144 fins per foot. No water carryover shall occur at design airflow and no anti-carryover coating shall be used.
- g. Suitable for 200 psig operation.
- h. Coils shall have drain and vent connections at supply and return headers. Install coils level for proper drainage. Coils shall be completely drainable. Minimum 1/2" OD tubes. Minimum 0.024" tube wall thickness.

K. Pre-Filter Section:

1. Provide side-loading particulate pre-filter section located downstream of return fan module as scheduled on drawings. Filter module shall be equipped with framing for 2" deep MERV-8 pleated media filters. Provide pre-filter module with full height hinged access door.
2. Maximum particulate pre-filter face velocity shall not exceed 230 feet/minute.
3. Reference Section 234000 for filter requirements.

L. Final Filter Section:

1. Provide front-loading final filter section located downstream of supply fan module as scheduled on drawings. Filter module shall be equipped with framing for 12" deep cartridge filters with seals on all four sides where each filter is inserted in the frame to prevent air bypass. Provide final filter module with full height hinged access door.
2. Maximum final filter face velocity shall not exceed 400 feet/minute.
3. Reference Section 234000 for filter requirements.

M. Intake/Hood: Provide intake/exhaust hood of same construction as main unit casing. The hood shall be sized for scheduled air flow.

N. External Pipe Cabinet:

1. Provide external pipe cabinet spanning all coil and humidifier sections.
2. Minimum cabinet depth shall be 36".
3. Pipe cabinet shall be supplied by the manufacturer.
4. Pipe cabinet shall be factory assembled and shall be of the same construction as the main unit casing.
5. The pipe cabinet shall be mounted externally and shipped loose to be field installed.
6. Provide one (1) access door. Each door shall be of the same construction as the unit doors and a minimum width of 20 inches.

O. Ultraviolet Germicidal Irradiation (UVGI):

1. Provided and installed by unit manufacturer. Refer to Section 233300 for requirements.
2. Portal: The UV lamp plenum area shall be equipped with a viewing port for viewing the lamp assembly. Portal shall be constructed to allow viewing without the possibility of exceeding the Minimal Erythermal Dose.
3. Interlock: Include all interlocks and wiring to assure UV light assembly is not energized when any access door is opened. Provide lockout tagout switches to turn off UV lamps when persons are in the unit. Signage shall indicate CAUTION: ULTRAVIOLET ENERGY IN DUCT. DO NOT OVERRIDE THE SAFETY DEVICE OR OTHERWISE ACTIVATE LAMPS WITH DOOR OPEN.
4. Location: System shall be installed a minimum of 8 inches and maximum of 20 inches from coil surface (based on UVC manufacturer's calculations and recommendations.) Install on tracks allowing the UV fixture to slide into place. Tracks shall be designed so the UV fixtures can be easily maintained and replaced. Interlock all UV lamps to turn on and off together.

P. Electrical Power:

1. Provide factory-mounted, weather-resistant (enclosed and gasketed), vapor-tight light fixtures in each accessible section of the unit. The fixture shall be complete with junction box, globe, aluminum globe guard, switch, receptacle, and bulb. Provide with factory-mounted outdoor service receptacles. Lighting and utility receptacles shall be wired to a single 120-volt point, terminating at a designated junction box mounted on the air-handling unit. The Mechanical Contractor is responsible to complete all wiring connection between shipping splits after assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements

1. Install per manufacturer's instructions.
2. During construction provide temporary closures of metal or taped polyethylene over openings into casing ducts to prevent dust from entering ductwork.
3. Seal all contractor installed penetrations airtight. Seal all openings prior to cleaning. Seal holes with proper SMACNA closures conforming to pressure class of the casing.
4. Contractor shall coordinate unit access stair and walkway placement to ensure compliance with OSHA requirements.

B. Coil Requirements:

1. Comb all coils to repair bent fins.
2. Extend coil drain and vent connections to outside unit casing. Provide normally closed valve on drain and vent connection outside of unit casing.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Provide factory authorized field representative for starting unit and training operator.
- B. Prepare and start systems with installing contractor observation.

END OF SECTION

SECTION 238200 - TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fan Coil Units.

1.2 QUALITY ASSURANCE

- A. All filters shall be UL listed Class 1 or Class 2.
- B. All electrical equipment shall have a UL label.
- C. All gas fired units shall be AGA approved or UL listed.
- D. All gas trains shall comply with utility company and code requirements.
- E. All louvers and dampers shall have AMCA certified ratings.
- F. Factory wired equipment shall conform to ANSI/NFPA 70.

1.3 REFERENCES

- A. ANSI/ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ANSI/NFPA 70 - National Electrical Code.
- D. ASHRAE 200 - Methods of Testing Chilled Beams

1.4 SUBMITTALS

- A. Submit shop drawings per Section 230500.
- B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.
- C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.
- D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.
- E. Submit manufacturers' installation instructions.

- F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- G. Where color selection by Architect is necessary, provide physical color charts for color selection directly to the Architect. Electronic color charts are not acceptable.
- H. Submit certification that terminal heat transfer units, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:
 - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ASHRAE 90.1.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

PART 2 - PRODUCTS

2.1 FAN COIL UNITS

- A. Units shall include cabinet, fan, motor, coils, filter and discharge grille.
- B. Exposed cabinets shall be minimum 18 gauge steel with baked enamel finish, color selected by the Architect and no plastic exposed parts. Cabinet shall be insulated with 1/2" thick closed cell elastomeric foam insulation with maximum K value of 0.25 at 75F, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723
- C. Fans: Centrifugal forward-curved, double-width with galvanized steel scrolls. Fans shall be statically and dynamically balanced to reduce noise levels.

- D. Motor: Fan motor voltage shall be as scheduled on the drawings. Motors shall be permanently lubricated, direct drive.
 - 1. Electronically commutated motor (ECM).
- E. Coils shall have copper headers and tubes and aluminum fins.
- F. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044 oz per ft² of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
- G. Overflow Protection: Provide water-level detection device conforming to UL508 in the primary drain pan that shuts down the equipment.
- H. Provide condensate piping and tie into drainage system.
- I. Filters: 1" woven glass fiber disposable type.
- J. Disconnect: Provide unit-mounted disconnect switch.
- K. Speed Control: Provide unit mounted fan speed control.
- L. Provide oversized left and right end piping compartments.
- M. Provide with tamperproof cabinet front.
- N. Manufacturers:
 - 1. Air-Therm
 - 2. Trane
 - 3. Daikin
 - 4. IEC
 - 5. Enviro-Tech/JCI
 - 6. Nailor
 - 7. Williams
 - 8. First Co.
 - 9. Zehnder-Rittling

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
- B. Install all products per manufacturers' instructions.
 - 1. Coordinate recess sizes for recessed equipment.
 - 2. Protect units with protective covers during construction.
 - 3. Comb all coils to repair bent fins.

3.2 CLEANING

- A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.
- C. Install new filters.

END OF SECTION

SECTION 238216 - AIR COILS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Water Coils.

1.2 REFERENCES

- A. ANSI/AHRI 410 - Forced-Circulation Air Cooling and Air Heating Coils.
- B. ANSI/NFPA 70 - National Electrical Code.
- C. ANSI/UL 1096 - Electric Central Air Heating Equipment.
- D. SMACNA - HVAC Duct Construction Standards, Metal and Flexible.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 230500.
- B. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- C. Submit manufacturer's installation instructions.
- D. Submit manufacturer's data showing that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.
- E. Submit certification that air coils, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:
 - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- B. Protect coils from entry of dirt and debris with pipe caps or plugs.
- C. Protect coolers from dirt and debris.

PART 2 - PRODUCTS

2.1 HOT WATER COILS

- A. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
- B. Suitable for continuous operation at 200 psi. Maximum air velocity of 1,000 fpm.
- C. Galvanized steel casing.
- D. AHRI rated with 0.0005 tube side fouling factor.
- E. Coils shall be sized based on EWT, EAT, gpm and cfm as scheduled. LAT shall be at least as high as scheduled. APD and WPD shall not exceed scheduled values.
- F. Maximum 144 fins per foot.
- G. Turbulators are not permitted. Turbulators shall not be allowed if removable headers are specified.
- H. Coils shall have vent connections, with valves, at the supply and return headers.
- I. Install coils level to allow drainage.
- J. Coils scheduled for over 2,000 cfm shall have valved drain connections at both headers.
- K. Headers and pipe connectors shall be copper or brass for use in copper piping systems or cast iron with ferrous pipe connectors for use in steel piping systems. If header material does not match the piping material, use dielectric fittings at the change in material.
- L. All duct coils shall have slip and drive connections with clearance sufficient for removal of coils from ducts.
- M. Minimum 0.024" tube wall thickness.
- N. Manufacturers:
 - 1. Trane
 - 2. York

3. Daikin
4. Heatcraft
5. Commercial Coil
6. American Air Filter
7. Coilmaster

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install coils in accordance with manufacturer's instructions. Pipe coils with air flow and water flow in opposite directions (counter flow).
2. Protect coils to prevent damage to fins and flanges.
3. Make connections to coils with offsets and unions or flanges to allow coil to be removed without disturbing valves.
4. Comb all coils to repair bent fins.

B. Duct Mounted Coil:

1. Install in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.
2. Insulate U-bends located outside ducts or casings as specified for ductwork.

END OF SECTION

SECTION 238413 - HUMIDIFIERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Condensate Cooler
- B. Electric Steam Humidifier Electrode

1.2 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 230500. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
- B. Submit schedule indicating manufacturer, model number, size, location, rated capacity, and features for each specialty.
- C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- D. Submit manufacturer's installation instructions.
- E. Submit operation and maintenance data.
- F. Submit certification that all steam and steam condensate specialties, accessories, and components will withstand seismic forces defined in Section 230550. Include the following:
 - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 ELECTRIC STEAM HUMIDIFIER (ELECTRODE TYPE)

- A. Packaged unit, wall hung, electric steam generator.
- B. Enclosure shall be an 18-gauge steel frame with cover suitable for finished spaces. Enclosure frame shall include a drip pan with a connection for drain piping. Separate compartments shall house electrical devices. The front exterior of the cabinet shall contain the microprocessor controller's digital keypad.
- C. Replaceable Canister: Shall be polypropylene and contain electric heating elements.
- D. Steam outlet on top of tank shall be configured to connect to the piping to the duct-mounted dispersion manifold.
- E. Water Requirements: The humidifier shall be capable of generating steam from softened water.
- F. Over-Temp Switch: A factory-mounted and wired sensor with manual reset shall sense an over-temperature condition and de-energize heater circuit controls.
- G. An electric drain valve shall be mounted on the humidifier assembly to allow tank to automatically back flush and drain at the end of a humidification season. Units with 33 lbs/hr. or greater capacity shall include a flushing/drain pump.
- H. Humidifier Controls:
 - 1. Microprocessor controller with the following features or functions:
 - a. Makeup water switch control and low water safety shutdown.
 - b. Fully modulating (0% to 100%) control of humidifier outputs.
 - c. Self-diagnostic test at startup.
 - d. Auxiliary contacts to DDC system.
 - e. Duct-mounted humidity sensor.
 - f. Airflow proving switch. Unit shall not operate without proof of airflow.
 - g. Adjustable high limit duct humidity switch.
 - h. A unit-mounted keypad capable of monitoring and/or controlling the following parameters:
 - 1) Relative humidity setpoint and actual conditions in space.
 - 2) Relative humidity high level setpoint and actual conditions.
 - 3) Total system demand in percentage of humidifier capacity.
 - 4) Total system output in lbs./hr.
 - 5) Drain/flush frequency interval and duration.
 - 6) End-of-season drain status.
 - 7) System alarms.
 - 8) Previous fault messages.
 - 9) Operating temperature.

2. Water Level Control: System shall provide for automatic refill, low water cutoff, field-adjustable skimmer bleed-off functions, and automatic drain-down of humidifier.
 3. In the absence of a space RH sensor supplied by the TCC, the humidifier supplier shall provide a space humidity sensor to the MC. The MC shall install the sensor or coordinate its installation with the TCC, if applicable, for control by the humidifier's microprocessor controls.
- I. A thermostatically controlled water valve shall meter an amount of cold water into a mixing chamber to temper 212F water to a 140F discharge temperature to sanitary system.
 - J. Humidifier Dispersion, Duct Distribution Unit: Duct-mounted stainless steel dispersion tube or manifold to provide required steam distribution. Maximum total absorption distance not to exceed 3'-0".
 - K. Humidification system dispersion tube hot surfaces in the airstreams of ducts or air-handling units shall be insulated with a product with an insulating value of at least 2.0 maximum 'K' value at 75F. Insulation product shall be closed cell, non-toxic, shall be highly resistant to UV light exposure, shall not absorb water or support microbial growth, and shall meet flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723. Insulation product shall remain stable (material shall not degrade, harden or crumble) when operated continuously at temperatures up to 300F.
 - L. Supply one replacement canister with each humidifier.
 - M. Manufacturers:
 1. Armstrong
 2. Carel
 3. Condair
 4. DriSteem
 5. Pure Humidifier
 6. Pre-approved equivalent

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

- A. General Installation Requirements:
 1. Install specialties in accordance with manufacturer's instructions.

3.2 HUMIDIFIERS

- A. Install components plumb and level, in accordance with approved shop drawings, product installation details and manufacturer's recommendations.
 1. Install humidifiers per manufacturers' instructions.

2. Seal humidifier dispersion-tube duct penetrations with flange.
 3. Install with required clearance for service and maintenance.
- B. Provide humidifiers with complete standalone control system. Control wiring associated with the humidifier and attached sensors is the responsibility of this Contractor.
- C. Testing and Adjusting:
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections.
 2. Test Results: Reported in writing to Architect/Engineer.
 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Training:
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers.
 2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 3. Review data in maintenance manual

END OF SECTION

SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Interior Communications Pathways Section 270528. This section is also applicable to Fire Alarm and Detection Systems Section 283100.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)

1.3 SCOPE OF WORK

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Electrical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- D. Description of Systems shall be as follows:
 - 1. Electrical power system to and including luminaires, equipment, motors, devices, etc.
 - 2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.
 - 3. Grounding system.
 - 4. Fire alarm system.
 - 5. Public address and intercom system.
 - 6. Nurse call system.
 - 7. Security system.
 - 8. Wiring system for temperature control system as shown on the drawings.
 - 9. Wiring of equipment furnished by others.
 - 10. Removal work and/or relocation and reuse of existing systems and equipment.
 - 11. Technology Systems as described in Division 27/28 and on the T-series documents as described in the Suggested Matrix of Scope Responsibility.

E. Work Not Included:

1. Telecommunications cabling will be by Division 27, in raceways and conduits furnished and installed as part of the Electrical work.
2. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

1.4 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours are required.

1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, and CONTROL CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
2. "Technology Contractors" refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.
3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
4. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.

7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
9. Low Voltage Technology Wiring: The wiring associated with the technology systems, used for analog or digital signals between equipment.
10. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications/technology information outlets.

C. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
4. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
 - a. Luminaires.
 - b. Gravity flow piping, including steam and condensate.
 - c. Electrical bus duct.
 - d. Sheet metal.
 - e. Cable trays, including access space.
 - f. Other piping.
 - g. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:

1. Wiring of all devices needed to make the Temperature Control System functional.
2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:

1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

G. General (Electrical/Technology):

1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".

2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.
3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.
4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

H. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility".
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the telecommunications ground bar.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

- b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

a. Scale of drawings:

- 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
 3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
 4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect/Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Architect/Engineer and Owner's Representative. The Architect/Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.
 2. A plotted set of coordination drawings shall be available at the project site.
 3. Coordination drawings are not shop drawings and shall not be submitted as such.
 4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
 5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
 6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
 7. The Architect/Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
 8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect/Engineer.
 9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
- a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.

- c. Additional access panels shall not be allowed without written approval from the Architect/Engineer at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect/Engineer and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
- 10. Complete the coordination drawing process and obtain sign-off of the drawings by all contractors prior to installing any of the components.
 - 11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
 - 12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.7 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

- 1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
- 2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor's risk.

B. Qualifications:

- 1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.
- 2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

C. Compliance with Codes, Laws, Ordinances:

- 1. Conform to all requirements of the State of Arkansas Codes, Laws, Ordinances and other regulations having jurisdiction.
- 2. Conform to all published standards of Mercy Hospital.

3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. If there are no local codes having jurisdiction, the current issue of the National Electrical Code shall be followed.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.
8. Pay all telephone company charges related to the service or change in service.

E. Examination of Drawings:

1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.
3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.

6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.
8. Where used in electrical documents the word "furnish" shall mean supply for use, the word "install" shall mean connect up complete and ready for operation, and the word "provide" shall mean to supply for use and connect up complete and ready for operation.
9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.

F. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.

1.8 WEB-BASED PROJECT SOFTWARE

- A. The General Contractor shall provide a web-based project software site for the purpose of hosting and managing project communication and documentation until completion of the warranty phase.

- B. The web-based project software shall include, at a minimum, the following features: construction schedule, submittals, RFIs, ASIs, construction change directives, change orders, drawing management, specification management, payment applications, contract modifications, meeting minutes, construction progress photos.
- C. Provide web-based project software user licenses for use by the Architect/Engineer. Access will be provided from the start of the project through the completion of the warranty phase.
- D. At project completion, provide digital archive of entire project in format that is readable by common desktop software applications in format acceptable to Architect/Engineer. Provide data in locked format to prevent further changes.

1.9 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item	Coordination Drawing
26 05 35	Surface Raceways	
26 05 48	Seismic Requirements for Equipment and Supports	
26 09 33	Lighting Control System	
26 24 19	Motor Control	
26 28 16	Disconnect Switches	Yes
26 29 23	Variable Frequency Drives	Yes
26 51 19	LED Lighting	Yes
28 31 01	Fire Alarm and Detection Systems	Yes

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

- a. Date
- b. Project title and number
- c. Contractor's name and address
- d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
- e. Description of items submitted and relevant specification number
- f. Notations of deviations from the contract documents
- g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

- a. Date
- b. Project title and number

- c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
3. Composition:
- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

- 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
- a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal, excluding mailing.

16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 26 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 26 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.10 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING and MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.
- B. Protect equipment, components, and openings with airtight covers and exercise care at every stage of storage, handling, and installation of equipment to prevent airborne dust and dirt from entering or fouling equipment to include, but not limited to:
 1. Distribution equipment - branch panels, distribution panels, switchboards, motor control centers, etc.
 2. Variable frequency drives.

3. Transformers, ventilated.
 4. Electronic equipment, UPS, harmonic filters, power factor correction.
 5. Lighting luminaires and lighting control systems.
- C. Equipment and components that are visibly damaged or have been subject to environmental conditions prior to building turnover to Owner that could shorten the life of the component (for example, water damage, humidity, dust and debris, excessive hot or cold storage location, etc.) shall be repaired or replaced with new equipment or components without additional cost to the building owner.
- D. Keep all materials clean, dry and free from damaging environments.
- E. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, they shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- F. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.
- 1.12 WARRANTY
- A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.
- 1.13 INSURANCE
- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.
- 1.14 MATERIAL SUBSTITUTION
- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality.

- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.
 - C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
 - D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on the Contractors part or on the part of other Contractors whose work is affected.
 - E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.
- 1.15 PROJECT COMMISSIONING
- A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 26 08 00 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:
1. Placing fill over underground and underslab utilities.
 2. Covering exterior walls, interior partitions and chases.
 3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation:
1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
 - a. All junction boxes are closed and identified in accordance with Section 260553 Electrical Identification.
 - b. Luminaires, including ceiling-mounted exit and emergency lights, are installed and operational.
 - c. Luminaire whips are supported above the ceiling.
 - d. Conduit identification is installed in accordance with Section 260553 Electrical Identification.
 - e. Luminaires are suspended independently of the ceiling system when required by these contract documents.
 - f. All wall penetrations have been sealed.
 2. To prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until full access has been provided.

3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
 1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
 3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.
 4. Contractor shall notify Architect/Engineer 48 hours prior to installation of ceilings or lay-in ceiling tiles.
- C. The following must be submitted before Architect/Engineer recommends final payment:
 1. Operation and maintenance manuals with copies of approved shop drawings.
 2. Record documents including reproducible drawings and specifications.
 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.
 4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed and submit receipt to Architect/Engineer.
 5. Inspection and testing report by the fire alarm system manufacturer.
 6. Start-up reports on all equipment requiring a factory installation or start-up.
- D. Circuit Directories:
 1. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

3.4 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div26.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div26.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copies of all factory inspections and/or equipment startup reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
7. Dimensional drawings of equipment.
8. Detailed parts lists with lists of suppliers.
9. Operating procedures for each system.
10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
11. Repair procedures for major components.
12. Replacement parts and service material requirements for each system and the frequency of service required.
13. Instruction books, cards, and manuals furnished with the equipment.
14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.
15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

3.5 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
 1. Maintenance of equipment.
 2. Start-up procedures for all major equipment.
 3. Description of emergency system operation.
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.
- F. Minimum hours of instruction time for each item and/or system shall be as indicated in each individual specification section.
- G. Operating Instructions:
 1. Contractor is responsible for all instructions to the Owner's representatives for the electrical and specialized systems.

2. If the Contractor does not have staff that can adequately provide the required instructions, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.6 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.
- F. Record actual routing of conduits exceeding 2 inches.

3.7 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.8 SPECIAL REQUIREMENTS

- A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.
- B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.

- D. Raceway and Cable Routing Restrictions: Raceways and cable are restricted from being routed in the following locations, unless serving the space or permitted by the authority having jurisdiction.

1. Exit enclosures.
2. Other areas restricted by code.
3. Technology, data, server rooms.
4. Fire pump and sprinkler rooms.
5. Normal power in emergency power equipment rooms: Limited to feeders and branch circuits serving the emergency power equipment located in the room.
6. Emergency power in normal power equipment rooms: Limited to feeders and branch circuits serving the normal power equipment located in the room.

3.9 INDOOR AIR QUALITY (IAQ) MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Within the Limits of Construction:

1. The Electrical Contractor shall coordinate all work with the contractor responsible for IAQ.
2. The means, methods and materials used by the Electrical Contractor shall be coordinated with the contractor responsible for IAQ and shall comply with the IAQ requirements set forth in Division 1 and Division 21/22/23 of these specifications.

- B. Outside the Limits of Construction:

1. IAQ shall be the responsibility of the electrical contractor for work that is required outside the limits of construction.
2. The Electrical Contractor is responsible for the IAQ set forth in Division 1 and Division 21/22/23 of these specifications.
3. The Electrical Contractor shall review and coordinate all IAQ plans and procedures with the owner's IAQ representative.

- C. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. General Contractor shall erect and maintain dust barriers throughout the construction work. These barriers shall be reasonably airtight and shall prevent entry into the construction zone by unauthorized persons. Reasonably airtight means construction equivalent to full-height temporary or permanent walls with joints taped or sealed, and shafts and other penetrations sealed as well as possible. Fire resistant polyethylene is acceptable; if flame spread/smoke developed ratings are demonstrated to conform to the applicable building codes and licensing acts.
2. The Contractor shall continuously maintain the construction zone under a negative pressure of at least 0.01" w.g. minimum relative to all adjacent areas of the building.

- a. Exhaust fans used for this purpose shall filter air and discharge it outdoors or to the least populated area adjacent to the construction work using negative air machines designed specifically for this purpose. All filtration for air recirculated back into the building shall be HEPA (99.97% DOP efficiency) for work adjacent to healthcare or elderly facilities. If no work is adjacent to these areas, 95% filtration is acceptable. Filtering air discharged to outdoors shall be accomplished with 30% filters.
 - b. If air is discharged outdoors, maintain all required distances to doors, windows, air intakes, etc.
 - c. If high levels of Volatile Organic Compounds (VOC's) or odors are released, activated carbon or equivalent filtration shall also be employed. Exhaust shall not discharge near doors, air intakes, pedestrians, gathering areas, or operable windows.
 - d. Adjusting existing air handling equipment to assist in pressure control is acceptable, if approved by the Owner and the authority having jurisdiction.
 - e. Seal return, exhaust, and supply air openings in or near the construction zone that serve existing air handling systems, and rebalance the systems for proper operation. If this is impractical, add filters at the intakes of sufficient cross sectional area to minimize the pressure drop and avoid the need for rebalancing.
 - f. Maintain pressure control one hour before and after all construction periods, and 24 hours per day in healthcare or elderly facilities.
3. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
 - a. Minimizing the amount of dust generated.
 - b. Reducing solvent fumes and VOC emissions.
 - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
4. Request that the Owner designate an IAQ representative.
5. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
6. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
7. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
8. Request copies of and follow all Owner's IAQ and infection control policies.
9. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
10. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
11. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings under Construction".

3.10 SYSTEM STARTING AND ADJUSTING

- A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.
- C. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.
- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.11 FIELD QUALITY CONTROL

- A. General:
 - 1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester's name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.
 - 2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
 - 3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
 - 4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
 - 5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than Electrical Code Standards. Take readings between conductors, and between conductors and ground.
 - 6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.

B. Ground-Fault Equipment Performance Testing:

1. Test: Perform ground-fault performance testing when system is installed. The test process shall use primary current injection per manufacturer instruction and procedures. Perform test for the following:
 - a. Service disconnects
 - b. Solid state molded case circuit breakers and solid-state insulated case circuit breakers equipped with ground fault protection.
 - c. Fusible switches with ground fault relay protection.
 - d. Outside branch circuits and feeders.
 - e. Code required.
2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.

C. Other Equipment:

1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.
- D. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.
- E. Contractor shall thermographic study all electrical gear, switchboard, panelboards, etc. at the end of construction to identify any unusual conditions/heating within the equipment. Coordinate with Owner/Architect/Engineer to have an Owner/Architect/Engineer representative present during testing.
- F. Report shall include color printouts, in binder, of pictures taken to use as a baseline reading after building is occupied.
- G. Upon completion of the project, the Contractor shall provide amperage readings for all panelboards and switchboards and turn the results over to the Owner for "benchmark" amperages.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to requesting a final job observation.

1. Penetrations of fire-rated construction fire sealed in accordance with specifications.
2. Electrical panels have typed circuit identification.
3. Smoke and fire/smoke dampers are wired and have been tested.
4. Per Section 260500, cable insulation test results have been submitted.
5. Operation and Maintenance manuals have been submitted as per Section 260500.
6. Bound copies of approved shop drawings have been submitted as per Section 260500.
7. Report of instruction of Owner's representative has been submitted as per Section 260500.
8. Fire alarm inspection and testing report has been submitted as per Sections 26 05 00 and 28 31 00.
9. Start-up reports from factory representative have been submitted as per Section 260500.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 260505 - ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY BOX, CONDUIT, OR WIRE THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS.
- B. Where walls, ceilings, structures, etc., are indicated as being removed on general or electrical drawings, the Contractor shall be responsible for the removal of all electrical equipment, devices, fixtures, raceways, wiring, systems, etc., from the removed area.
- C. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.
- D. Where mechanical or technology equipment is indicated as being removed on electrical, mechanical, or technology drawings, the Contractor shall be responsible for disconnecting the equipment and removing all starters, VFD, controllers, electrical equipment, raceways, wiring, etc. associated with the device.
- E. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area. Extended conduit and conductors to match existing size and material.
- F. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and electrical service to avoid conflicts.
- G. Bid submittal shall mean the Contractor has visited the project site and has verified existing conditions and scope of work.

3.2 PREPARATION

- A. The Contractor shall obtain approval from the Owner before turning off power to circuits, feeders, panels, etc. Coordinate all outages with Owner.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.
- C. Disconnect electrical systems in walls, floors, structures, and ceilings scheduled for removal.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 48 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Service changeover shall be completed on an overtime basis.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Obtain permission from Owner at least 48 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Provide a watchman to make required premise observations during all outages, requirements as dictated by codes and Owner's insurance carrier.
- F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 48 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. System changeover shall be completed on an overtime basis.
- G. Existing Nurse Call System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the Owner at least 48 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. System downtime shall occur on an overtime basis.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work under provisions of Division 1 of Specifications and this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.

- C. Remove abandoned wiring and raceway to source of supply. Existing conduit in good condition may be reused in place by including an equipment ground conductor in reused conduit. Reused conduit and boxes shall have supports revised to meet current codes. Relocating conduit shall not be allowed.
- D. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.
- E. Disconnect and remove outlets and devices that are to be demolished. Remove outlet or devices' associated back box, supports, and conduit and conductors back to source. Patch opening created from removal of device to match surrounding finishes.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories. Ballasts in light fixtures installed prior to 1980 shall be incinerated in EPA approved incinerator or disposed of in EPA certified containers and deposited in an EPA landfill certified for PCB disposal or recycled by permitted ballast recycler. Punctured or leaking ballasts must be disposed of according to Federal Regulations under the Toxic Substance Control Act. Provide Owner and Architect/Engineer with a Certificate of Destruction to verify proper disposal.
- I. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.
- J. Maintain access to existing electrical installations that remain active. Modify installation or provide junction boxes and access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. Extended conduit and conductors to match existing size and material.
- L. HID and fluorescent lamps, determined by the Toxicity Characteristic Leachate procedure (TCLP), to be hazardous waste shall be disposed of in an EPA-permitted hazardous waste disposal facility or by a permitted lamp recycler.
- M. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- N. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to structural plans for additional information.

- O. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes X-ray or similar non-destructive means. Where conduit is in concrete slab, cut conduit flush with floor, pull out conductors, and plug conduit ends.
- P. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.4 EXISTING ENCLOSURES - NEW EQUIPMENT

- A. Existing enclosures may be reused to house new equipment including branch panels, industrial controls, and similar systems pending documented verification of the following provided with the applicable new equipment submittals.
 - 1. New equipment or panelboard is listed for the existing enclosure or application.
 - 2. Existing enclosure and new equipment is field evaluated by the manufacturer or nationally recognized testing laboratory for the available fault current, condition, and application.
 - 3. Authority Having Jurisdiction (AHJ) approval.

3.5 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C. Luminaires: Remove existing luminaires for cleaning as indicated on the drawings. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts. Replacement parts shall match specified components for new luminaires of same type when applicable. Reinstall luminaire and connect to circuiting as indicated on drawings.
- D. ELECTRICAL ITEMS (E.G., LIGHTING FIXTURES, RECEPTACLES, SWITCHES, CONDUIT, WIRE, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.6 INSTALLATION

- A. Install relocated materials and equipment under the provisions of Division 1 of Specifications.

END OF SECTION

SECTION 260513 - WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Building Wire - Copper
- B. Cabling for remote control, signal, and power limited circuits
- C. Healthcare facilities cable (HFC)

1.2 RELATED WORK

- A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

- A. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
- B. NFPA 70 - National Electrical Code (NEC)
- C. UL 44 - Thermoset-Insulated Wires and Cables
- D. UL 83 - Thermoplastic-Insulated Wires and Cables
- E. UL 854 - Service-Entrance Cables
- F. UL 1581 - Standard for Electrical Wires, Cables, and Flexible Cords
- G. UL 2196 - Fire Resistive, Fire Resistant and Circuit Integrity Cables

PART 2 - PRODUCTS

2.1 BUILDING WIRE - COPPER

- A. The basis of design is copper conductor. Aluminum and Copper-Clad Aluminum conductors are NOT allowed for the project.
- B. Feeders and Branch Circuits 8 AWG and larger: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.
- C. Feeders and Branch Circuits 8 AWG and larger in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.
- D. Feeders and Branch Circuits 10 AWG and Smaller: Copper, solid or stranded conductor, 600-volt insulation, THHN/THWN, unless otherwise noted on the drawings.

- E. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings. Three conductor stranded copper, 600-volt XHHW-2 insulation, with copper ground and overall helical copper tape shield. Shield shall be terminated at both ends of cable with an approved termination.
- F. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.
- G. Operating Room Power Isolation Systems: Copper, stranded conductor, with low leakage insulation, Type 'XLP' 'XHHW-2'.
- H. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

2.2 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS

- A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.
 - 1. Fire alarm
 - 2. Low voltage switching and lighting control
 - 3. Electronic control
 - 4. Other specialized cabling, signal, and power limited cabling. Refer to the appropriate Division 23, 27, or 28 requirements; including, but not limited, to the following:
 - a. Building Automation Systems and Controls, Division 23.
 - b. Nurse Call, Division 27.
 - c. Electronic Access Control, Intrusion Detection Systems, Video Surveillance, Division 28.
- B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
- D. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.3 HEALTHCARE FACILITIES CABLE (HFC)

- A. At the Contractor's option, healthcare-grade armored cables with redundant copper ground conductor may be used for branch circuit wiring as defined in the Electrical Code subject to acceptance by State and local codes. Healthcare armored cable shall include a green identifying strip on the exterior of the armor.

- B. Armored cable shall be constructed in strict accordance with Underwriters Laboratories, Inc., Standard for Type AC Cables, UL 4, and include flexible metallic interlocked armor.
- C. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.
- D. Armored cable shall NOT be used for circuits serving the Essential Electrical System.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE

- A. Above Accessible Ceilings:
 - 1. Building wire shall be installed in raceway.
 - 2. Metal clad cable, Type MC, 1/2" size with minimum #12 conductors and ground, shall be allowed for flexible whips to individual luminaires on non-essential circuits. The flexible whips shall be between 18" to 72" in length per Electrical Code.
- B. All Other Locations: Building wire in raceway.
- C. Above Grade: All conductors installed above grade shall be type "THHN".
- D. Underground or In Slab: All conductors shall be type "THWN".
- E. Low Voltage Cable (less than 100 volts): Low voltage cables in ducts, plenums, and other air handling spaces shall be plenum listed. Low voltage cables in non-accessible areas shall be installed in conduit. Low voltage cable may be installed without conduit in accessible areas using the following types of cable supports. Cable support types/systems shall comply with the warranty requirements of the low voltage cable manufacturer.
 - 1. J-hooks
 - 2. Bridle rings with saddle supports

3.2 CONTRACTOR CHANGES

- A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30C.
- B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if other than the basis of design.
- C. Underground electrical duct ampacity rating shall be in accordance with NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)) or calculated in accordance with Annex B Application Information for Ampacity Calculation. The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.

- D. Conductor length(s) listed on plans and schedules. The drawings are diagrammatic with intent to convey the components of the electrical distribution system. Conductor length(s) when listed on plans and schedules are for engineering calculation purposes. Conductor length(s) shall NOT be used for bidding purposes.
- E. Record drawing shall include the calculations and sketches.

3.3 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.
- B. Use no wire smaller than 18 AWG for low voltage control wiring below 100 volts.
- C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.
- D. Use no wire smaller than 8 AWG for outdoor lighting branch circuits.
- E. The ampacity of multiple conductors in one conduit shall be derated per the Electrical Code. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.
- F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.
- G. Splice only in junction or outlet boxes.
- H. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- I. Make conductor lengths for parallel circuits equal.
- J. All conductors shall be continuous in conduit from last outlet to their termination.
- K. Terminate all spare conductors on terminal blocks, and label the spare conductors.
- L. Cables or wires shall not be laid out on the ground before pulling.
- M. Cables or wires shall not be dragged over earth or paving.
- N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
- O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.
- P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.4 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.
- D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreel and run into the conduit or duct with a minimum of change in the direction of the bend.
- E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.
- F. Only nylon rope shall be permitted to pull cables into conduit and ducts.
- G. Completely and thoroughly swab raceway system before installing conductors.
- H. Conductor Supports in Vertical Raceways:
 - 1. Support conductors in vertical raceways in accordance with the Electrical Code Spacing of Conductors Supports.
 - 2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

3.5 CABLE INSTALLATION

- A. Provide protection for exposed cables where subject to damage.
- B. Use suitable cable fittings and connectors.
- C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", recognized industry standards; and coordinated with other contractors.

- D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.
- E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.
- F. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.
- G. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

3.6 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice and tap only in accessible junction boxes.
- B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.
- C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.
- D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.
- E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.
- I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:

1. Facing the front and operating side of the equipment, the phase identification shall be:

- a. Left to Right - A-B-C
- b. Top to Bottom - A-B-C

- J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

3.7 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a "Megger". The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.
- C. MI cable shall have the insulation resistance of each cable tested with a 500-volt dc megohmmeter prior to energizing the cables. Tabulate resistance values and submit to Architect/Engineer for acceptance.
- D. Inspect wire and cable for physical damage and proper connection.
- E. Torque test conductor connections and terminations to manufacturer's recommended values.
- F. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.
- G. Provide documentation of the manufacturer's recommended lug torque value for copper and aluminum conductors, the date the lugs were torqued, and installed torque readings. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.
- H. Protection of wire and cable from foreign materials:
 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.

- I. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

END OF SECTION

SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment grounding system
- B. Bonding system

1.2 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
- B. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with UL 467 Grounding and Bonding Equipment.
- E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
- F. Comply with Electrical Code; for overhead-line construction and medium-voltage underground construction, comply with IEEE/ANSI C2 National Electrical Safety Code (NESC).

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)
- B. NFPA 99 - Standard for Healthcare Facilities

1.4 SUMMARY

- A. This section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section 260513 "Wire and Cable".

- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated. Refer to Section 260553 for insulation color.
- D. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- E. Copper Bonding Conductors: As follows:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- F. GB; Grounding Bar:
 - 1. Bare, annealed copper bars of rectangular cross section, with insulators. 1/4" x 2", length of technology or applicable room.
- G. IBT; Intersystem Bonding Termination:
 - 1. Copper bar, 1/4" x 2" x 24". Provide with wall mounting brackets, insulators and pre-tapped holes.
 - 2. Manufacturers:
 - a. Harger GBI Series.
 - b. Erico EGB Series.

2.2 CONNECTOR PRODUCTS

- A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Connectors: Hydraulic compression type Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- C. Bolted Connectors: Bolted-pressure-type connectors.
- D. Substation connectors shall comply with IEEE 837 listed for use for specific types, sizes, and combinations of conductors and connected items.

PART 3 - EXECUTION

3.1 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.
- G. Underground Connections: Exothermic-welded connections. Use for underground connections, except those at test wells.
- H. Connections at back boxes, junction boxes, pull boxes, and equipment terminations: The equipment grounding conductor(s) associated with all circuits in the box shall be connected together and to the box using a suitable grounding screw. The removal of the respective receptacle, luminaire, or other device served by the box shall not interrupt the grounding continuity. The connection to the non-metallic boxes shall be made to any metallic fitting or device requiring grounding.
- I. Tighten screws and bolts for grounding and bonding 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.
- J. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.2 INSTALLATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.
- C. In raceways, use insulated equipment grounding conductors.
- D. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.
- E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, below access floors, and elsewhere as indicated, with bolted connections to form a continuous ground path.

3.3 EQUIPMENT GROUNDING SYSTEM

- A. Comply with Electrical Code, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by Electrical Code are indicated.
- B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.
- C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by Electrical Code:
 - 1. Lighting and receptacle circuits. Terminate each end on a grounding lug or bus.
 - 2. Single-phase and three-phase motor and appliance branch circuits.
 - 3. Flexible raceway runs, including FMC and LFMC.

3.4 BONDING SYSTEM

- A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.
- B. Isolated Equipment Enclosure: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment bonding conductor.
- C. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.

- D. Equipment Circuits: Install a bonding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, dampers, and heaters. Bond conductor to each unit and to air duct. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps or copper conductor sized equal to the equipment grounding conductor.
- E. Bond metal ducts of dust collectors, particulate conveying, fume hoods, and other hazardous materials to the equipment grounding conductors of associated pumps, fans, or blowers. Use braided-type bonding straps. Provide braided bare copper bonding conductor in nonmetallic dust collector ductwork to each equipment inlet location, and bond to equipment.
- F. Water Heater, Heat-Tracing, Metal Well Casing, and Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, well casing, connected equipment, and components.
- G. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
- H. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated bonding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location. Leave 10 feet of slack conductor at terminal board.
- I. Telecom Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bar.
- J. Industrial Control Panels, Terminal Cabinets, and Similar Installation: Terminate bonding conductor on cabinet grounding terminal. Provide an equipment grounding conductor and bond adjacent and associated control panels together.
- K. Equipment Ground Conductor Continuity: All spliced equipment grounding conductors in junction boxes, cabinets, and distribution equipment shall be connected together and bonded to the metal enclosure.
- L. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.
- M. Medical Gas Piping: Bond to pipe with grounding clamp connectors. Bonding conductor shall be a #6 AWG minimum and may be connected to panelboard ground bar serving the area.

3.5 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation. The pad rebar shall be attached to the counterpoise conductor at the four corners.

3.6 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
 - 1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
 - 2. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:
 - 3. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
 - 4. Testing: Perform the following field quality-control testing:
 - a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - b. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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. Perform tests, by the fall-of-potential method according to IEEE 81.

- c. Provide drawings locating each 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.
 - 1) Equipment Rated 500 kVA and Less: 10 ohms.
 - 2) Equipment Rated 500 to 1000 kVA: 5 ohms.
 - 3) Equipment Rated More Than 1000 kVA: 3 ohms.
 - 4) Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - 5) Manhole Grounds: 10 ohms.
- d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

3.7 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2. Maintain restored surfaces. Restore disturbed paving.

END OF SECTION

SECTION 260527 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit and Equipment Supports
- B. Fastening Hardware

1.2 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.3 REFERENCES

- A. UL 62275 - Cable Management Systems - Cables Ties for Electrical Installations

1.4 COORDINATION

- A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Allied Support Systems
- B. Cooper B-Line
- C. Erico, Inc.
- D. Hilti
- E. Power Fasteners
- F. Orbit Industries

2.2 MATERIAL

- A. Support Channel: Hot-dip galvanized stainless steel for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.
- B. Hardware: Corrosion resistant.

C. Anchorage and Structural Attachment Components:

1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.
 - a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125/F3125M Standard Specification for High Strength Structural Bolts and Assemblies.
3. Welding Lugs: Comply with MSS-SP-69, Type 57.
4. Beam clamps for Steel Beams and Joists: Double sided or concentric open web joist hangers. Single-sided type is not acceptable.
5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.
7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

D. Conduit Sleeves and Lintels:

1. Each Contractor shall provide, to the General Contractor for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.
2. Refer to Structural plans and specifications for lintel requirements and sizes.
3. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Architect or Structural Engineer.
4. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.
5. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
6. Sleeves shall not penetrate structural members without approval from the Structural Engineer.

7. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
8. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
9. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
10. Size sleeves large enough to allow expansion and contraction movement.

E. Rooftop Support System:

1. Provide pre-fabricated roof supports for all conduit and equipment installed above the roof. Support all conduit and equipment a minimum of 4" above roof.
2. Support system shall be compatible with single ply, bituminous, metal, and spray foam roof systems. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
3. All metal components shall be hot dipped galvanized. Mounting hardware shall be stainless steel or hot dipped galvanized. Support shall be UV, corrosion, and freeze/thaw resistant. Support shall include orange paint, reflective safety orange accents, or similar markings for increased visibility.
4. Products:
 - a. Anvil International HBS-Base Series
 - b. Cooper B-Line Dura-Blok
 - c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load).

F. Truss and Joist Support System: Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
 - a. The hanger is attached within 6" from a web/chord joint.
 - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

G. Cable Ties for Cable Management Systems:

1. Cables ties, UL Listed, Type 21 or Type 21S, and test to UL Standard 62275 for Cable Management Systems.
2. Acceptable Applications: Low Voltage Wire and Cabling.
 - a. Bundle wires and cables within cable trays, auxiliary gutters, and similar applications.
 - b. Organize and support wiring and cables within equipment and distribution systems.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.
- B. Trapeze support installation: Cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- D. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.
- E. Do not use powder-actuated anchors without specific permission.
- F. Do not drill structural steel members.
- G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- H. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.
- I. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting. Provide steel channel supports to stand surface-mounted panelboard or cabinet one inch off wall.
- J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

- K. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- L. Refer to Section 260533 for special conduit supporting requirements.

3.2 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
- B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION

SECTION 260533 - CONDUIT AND BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Intermediate metallic conduit and fittings (IMC)
- B. Electrical metallic tubing and fittings (EMT)
- C. Liquidtight flexible metallic conduit and fittings (LFMC)
- D. Rigid polyvinyl chloride conduit and fittings (PVC)
- E. Wall and ceiling outlet boxes
- F. Electrical connection
- G. Pull and junction boxes
- H. Raceway Seals and Sealant
- I. Accessories

1.2 RELATED WORK

- A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
 - 2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
 - 3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
 - 4. ANSI C80.6 - Intermediate Metal Conduit, Zinc Coated
 - 5. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
 - 6. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
- B. Federal Specifications (FS):
 - 1. A-A-50553A - Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
 - 2. A-A-55810 - Specification for Flexible Metal Conduit
- C. NECA "Standards of Installation"

D. National Electrical Manufacturers Association (NEMA):

1. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
2. RN 1 - Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit, Rigid Aluminum Conduit, and Intermediate Metal Conduit
3. TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
4. TC 9 - Fittings for PVC Plastic Utilities Duct for Underground Installation

E. NFPA 70 - National Electrical Code (NEC)

F. Underwriters Laboratories (UL): Applicable Listings

1. UL 1 - Flexible Metal Conduit
2. UL 6 - Rigid Metal Conduit
3. UL 360 - Liquid Tight Flexible Steel Conduit
4. UL514-B - Conduit Tubing and Cable Fittings
5. UL651-A - Type EB and a PVC Conduit and HDPE Conduit
6. UL651-B - Continuous Length HDPE Conduit
7. UL746A - Standard for Polymeric Materials - Short Term Property Evaluations
8. UL797 - Electrical Metal Tubing
9. UL1242 - Intermediate Metal Conduit

G. Definitions:

1. Fittings: Conduit connection or coupling.
2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.
5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

PART 2 - PRODUCTS

2.1 INTERMEDIATE METALLIC CONDUIT (IMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

B. Manufacturers:

1. Atkore Allied Tube & Conduit
2. Nucor
3. Electroline
4. Western Tube
5. Wheatland Tube Co
6. or approved equal.

C. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

D. Manufacturers of IMC Conduit Fittings:

1. ABB/Thomas & Betts
2. Easton/Crouse-Hinds
3. Electroline
4. Emerson Appleton & OZ Gedney
5. Hubbell Raco and Killark
6. NSI Bridgeport
7. Orbit Industries
8. Wesco Regal
9. or approved equal.

2.2 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.

B. Manufacturers of EMT Conduit:

1. Allied Tube & Conduit
2. Calbond Calpipe
3. Nucor
4. Electroline
5. Western Tube
6. Wheatland Tube Co
7. or approved equal.

C. Fittings and Conduit Bodies:

1. 2" Diameter or Smaller: Compression or steel set screw type of steel designed for their specific application.
2. 1/2" and 3/4" Conduit: Push-on connectors and couplers with locking ring and washer of zinc plated steel, listed for use in dry locations.
3. Larger than 2": Compression or steel set screw type of steel designed for their specific application.
4. Manufacturers of EMT Conduit Fittings:
 - a. ABB/Thomas & Betts
 - b. Eaton/Crouse-Hinds
 - c. Electroline
 - d. Emerson Appleton & OZ Gedney
 - e. Hubbell Raco and Killark
 - f. NSI Bridgeport
 - g. Orbit Industries
 - h. Wesco Regal
 - i. or approved equal.

2.3 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

A. Manufacturers:

1. ABB/Thomas & Betts
2. Anamet Electrical
3. Atkore American Flex AFC and Flexicon
4. Electri-Flex Co
5. Electroline
6. Southwire Alflex
7. or approved equal.

B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.

C. Fittings and Conduit Bodies:

1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:
 - a. ABB/Thomas & Betts
 - b. Eaton/Crouse-Hinds
 - c. Electroline
 - d. Emerson Appleton & OZ Gedney
 - e. Hubbell Raco and Killark
 - f. NSI Bridgeport
 - g. Orbit Industries

- h. Wesco Regal
- i. or approved equal.

2.4 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

- A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.
- B. Acceptable Manufacturers:
 - 1. ABB/Carlton
 - 2. Chevron Phillips Chemical Company
 - 3. Cantex, J.M. Mfg.
 - 4. Atkore Heritage Plastics
 - 5. or approved equal.
- C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90C.
- D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
- E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	less than 0.941
D-1238	Melt Index, g/10 min Condition E	greater than 0.55 grams/10 min.
D-638	Tensile Strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B, F 20	96 hrs.
D-790	Flexural Modulus, MPa (psi)	less than 80,000
D-746	Brittleness Temperature	-75C Max

2.5 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, 16 gauge (approximately 0.0625 inches), with 1/2-inch male fixture studs where required.
- B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.
- C. Cast Boxes: NEMA FB1, Type FD, Aluminum, cast fer alloy, or stainless steel deep type, gasketed cover, threaded hubs.
- D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.

- E. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.
- F. Outlet boxes for telephone substations in walls and columns shall be 4 inches square and 2-1/8 inches deep with single gang raised cover to fit flush with finished wall line equipped with flush telephone plate.
- G. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.6 ECONN; ELECTRICAL CONNECTION

- A. Electrical connection to equipment and motors, sized per Electrical Code. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.7 JB; PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.
- C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.
- E. Flanged type boxes shall be used where installed flush in wall.

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40F to
T	Fire Seals (1 hour)	Silicone	-67F to
FS	Fire Seals (3 hours)	Silicone	-67F to 400F
OS	Oil Resistant / Stainless	Nitrile	-40F to 210F

2.8 RACEWAY SEALS AND SEALANT

- A. Duct Sealant: Field applied expandable duct sealant, closed cell field cured, water tight, air tight. Identified for use with electrical cables, conductors, and raceways. Minimum liquid withstanding of 10-feet head of water (5 PSI). Compatible with conductors and raceways, UL94 Flammability Certified.
 - 1. NOT ALLOWED. Duct seal putty, all-purpose construction sealant.
 - 2. Manufacturers:
 - a. Polywater FST / AFT Series
 - b. Approved equal
- B. Duct Seal Bushing: Custom mechanical seal, liquid tight, gas tight, stainless steel hardware. Minimum liquid withstanding of 10-feet head of water (5 PSI). Coordinate product with raceway size, cable quantities, and cable sizes.
 - 1. Manufacturers:
 - a. Polywater PHRD / PHSD Series Varia /PHSI Module Series
 - b. Jackmoon Commscope DuctPlug Series
 - c. CalAm Manufacturing WedgeSeal Series
- C. Duct Seal Bushing Alternative Option: Inflatable duct seal system. Capable of withstanding a 10-foot head of water (5 PSI).
 - 1. Manufacturers:
 - a. Raychem Rayflate Duct Sealing Systems RDSS
 - b. Approved equal
- D. Wall Sleeve Duct Seal System: Cast-in-place or Core-Drill two piece push-in- place construction, gasketed seal to prevent entry of water and gases.
 - 1. Cable: Duct Seal Bushing, provide interior sleeve duct seal bushing for each duct entry. Provide duct seal bushings with individual seals for each applicable cable.
 - 2. Manufacturers:
 - a. Polywater Varia PHSI Series
 - b. Approved equal

2.9 ACCESSORIES

- A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes. Kinetics Noise Control - IsoBacker Pad, SpecSeal - SSP Putty and Pads, 3M #MPP-4S or equal.
- B. Sound Barrier Insulation Pads: Mastic, non-hardening, sheet material, minimum 1/8" thickness applied to all five sides of back boxes. Kinetics Noise Control - SealTight Backer Pad, L.H. DOTTIE Co. #68 or equal.

- C. Electric Threaded Ball Swivel: Metallic body, box mounted, threaded conduit, 20-degree ball swivel, rated for weight of application, listed. Thomas and Betts, Appleton, Couse-hinds, or equal. Example applications:
 - 1. Rigid pendant mount with sloped ceiling, vibration, or subject to wind.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION SCHEDULE AND SIZING

- A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the Electrical Code shall be required.
- B. Installation Schedule: Refer to drawings.
- C. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to the Electrical Code. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.
- D. Minimum Conduit Size (Unless Noted Otherwise):
 - 1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
 - 2. Below Grade 5' or less from Building Foundation: 1 inch.
 - 3. Below Grade More than 5' from Building Foundation: 1 inch.
 - 4. Telecommunication Conduit: 1 inch.
 - 5. Controls Conduit: 3/4 inch.
- E. Conduit Embedded in Slabs above Grade:
 - 1. Embedded installation NOT allowed in elevated slabs with metal composite decks nor structural pour in place slabs less than 6 inches in depth unless specifically noted or shown on drawings otherwise.
 - 2. Maximum size 1 inch for conduits crossing each other.
- F. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.2 CONDUIT ARRANGEMENT

- A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.
- B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.
- C. Conduit arrangement in elevated slabs (restricted to applications specifically noted or shown on drawings):
 - 1. Conduit size shall not exceed one-third of the structural slab thickness. Place conduit between the top and bottom reinforcing with a minimum of 3" concrete cover.
 - 2. Parallel conduits shall be spaced at least 8 inches apart. Exception: Within 18 inches of commonly served floor boxes, junction boxes, or similar floor devices. Arrange conduits parallel or perpendicular to building lines and walls.
- D. Conduit shall not share the same cell as structural reinforcement in masonry walls.
- E. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.
- F. Contractor shall adapt Contractor's work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.
- G. Contractor shall cooperate with all contractors on the project. Contractor shall obtain details of other contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by Contractor. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.3 CONDUIT SUPPORT

- A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

1. Support wire used to independently support raceway and wiring systems above suspending ceilings shall be supported on both ends, minimum 12 gauge suspended ceiling support wire, and distinguishable from ceiling support systems by color (field paint), tagging, or equivalent means.
- B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.
- C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.
- D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.
- F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.
- G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.
- J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.
- K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the Electrical Code requirements.
- L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.

M. Finish:

1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

3.4 CONDUIT INSTALLATION

A. Conduit Connections:

1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

C. Conduit Bends:

1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360 degrees), including those bends located immediately at the outlet or body.
4. Telecommunications conduits shall have no more than two (2) 90-degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.

a. A third bend is acceptable if:

- 1) The total run is not longer than (33) feet.
- 2) The conduit size is increased to the next trade size.

5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
6. Telecommunications Conduit(s): Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.
7. Rigid polyvinyl chloride conduit (PVC) runs longer than 100 feet or runs which have more than two 90-degree equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.
8. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. Seal penetrations with intumescent caulk, putty, or sheet installed per manufacturer's recommendations. All materials used to seal penetrations of firewalls and floors shall be tested and certified as a system per ASTM E814 Standard for fire tests or through-penetration fire stops as manufactured by 3M or approved equal.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20F to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, identified for use with cable and raceway system.

9. Horizontal conduit routing through slabs above grade
 - a. Conduits, if run in concrete structure, shall be in middle one-third of slab thickness, and leave at least 3" min. concrete cover. Conduits shall run parallel to each other and spaced at least 8" apart centerline to centerline. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Maximum conduit outside diameter 1".
 - b. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.
 - c. No conduits are allowed to be routed horizontally through slabs above grade.
10. Do not route conduits across each other in slabs on grade.
11. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40F.
12. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to or PVC-coated steel or reinforced thermosetting resin conduit RTRC conduit shall be installed before conduit exits earth. The conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
13. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
14. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.
15. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3" above finished floor (AFF).
16. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4" below ceiling and as close to the wall as possible.
17. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4" above finished floor (AFF) and as close to the wall as possible.

3.5 CONDUIT TERMINATIONS

- A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.
- B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.
- C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.
- D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.

- E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the Electrical Code, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.
- F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.
- G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

3.6 UNDERGROUND CONDUIT INSTALLATION

- A. Conduit Connections:
 - 1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.
- B. Conduit Bends (Lateral):
 - 1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.
 - 2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.
- C. Conduit Elbows (vertical):
 - 1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (greater than 600V) and 18 inches for secondary conduits (less than 600V). Increase radius, as required, based on pulling tension calculation requirements.
- D. Expansion Fittings at Finished Grade: Provide underground raceways with an expansion fitting after emerging from finished grade and exterior equipment pads. Field locate the expansion fitting above and within 24 inches of finished grade. Raceways extending less than 12 inches above finished grade, transitioning to LFMC within 12 inches of finished grade, and interior concrete building slabs do not require an expansion fitting unless required by code.

E. Conduit Placement:

1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.
3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum $f'c = 2500$ and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
4. Before the Contractor pulls any cables into the conduit, Contractor shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
8. All non-metallic conduit installed underground outside of a slab shall be rigid.

F. Horizontal Directional Drilling:

1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.
2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

G. Raceway Seal (Exterior to Raceway):

1. All power, telecommunication, electrical conduits and innerducts shall be sealed between the raceway and the building foundation. The raceway penetration shall be sealed liquid-tight, water-tight, non-corrosive.
2. Below Grade Installation Options:
 - a. Cast-in-place concrete installation.
 - b. Hydraulic cement, hydraulic grout, hydraulic epoxy.
 - c. Foundation - Underground Sleeves and Seals; refer to Part 2-Products for product information.
3. Above Grade Installation Options:
 - a. Masonry grout for masonry applications.

- b. Caulk Sealant, interior/exterior rated, color per architect. Refer to architectural specifications for additional requirements. Approved Manufacturers include Sachco, Tremco Vulkem, Sika or approved equal when not specified by architectural scope.

H. Raceway Seal (Interior to Raceway, with Cables or Empty):

1. All power, telecommunication, electrical conduits and innerducts, including those with cables, shall be sealed at the building and vault entry. The seal shall prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceways shall also be sealed.
2. Installation Schedule, nominal size:
 - a. 2" or less: Duct Seal Bushing or Duct Sealnt
 - b. 2-1/2" through 4": Duct Seal Bushing
 - c. 5" and 6": Wall Sleeve Duct Seal System

3.7 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:

1. Concealed interior locations above ceilings and in hollow studed partitions.
2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
3. Direct contact with concrete except slab on grade.

B. Cast boxes shall be used in:

1. Exterior locations.
2. Exposed interior locations within 8' of the highest platform level.
3. Direct contact with earth.
4. Direct contact with concrete in slab on grade.
5. Wet locations.
6. Kitchens and laundries when exposed on wall surface.

3.8 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.
- C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Recessed luminaires shall not be used as access to outlet, pull, and junction boxes. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer and General Contractor.

- D. Locate and install to maintain headroom and to present a neat appearance.
- E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

3.9 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls.
 - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
 - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.
- C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)
- D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.
- E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- F. Provide knockout closures for unused openings.
- G. Support boxes independently of conduit.
- H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- I. Install boxes in walls without damaging wall insulation.
- J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.
- K. Position outlets to locate luminaires as shown on reflected ceiling drawings.

- L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- N. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

3.10 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- B. Support pull and junction boxes independent of conduit.
- C. Do not install boxes back-to-back in walls.
 - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
 - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

3.11 EXPOSED BOX INSTALLATION

- A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.
- B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.
- C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.
- D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.

- E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)
- F. Wood, plastic, or fiber plugs shall not be used for fastenings.
- G. Explosive devices shall not be used unless specifically allowed.

END OF SECTION

SECTION 260535 - SURFACE RACEWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Surface metal raceways

1.2 REFERENCES

- A. FS W-C-582 - Conduit, Raceway, Metal, and Fitting; Surface

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 260500.
- B. Include product data for surface metal raceways, multi-outlet assemblies, surface non-metallic raceways, auxiliary gutters, and accessories.

PART 2 - PRODUCTS

2.1 SURFACE METAL RACEWAY

- A. Surface Metal Raceway: FS W-C-582; sheet metal channel with fitted cover, suitable for use as a continuous surface metal raceway.
- B. Finish: Rust inhibiting primer coat for field painting. Coordinate paint color with Architect.
- C. Fittings: Couplings, elbows, and connectors designed for use with raceway system.
- D. Boxes and Extension Rings: Designed for use with raceway systems.
- E. Coverplates shall be same material and finish as raceway.
- F. Normal power receptacles shall be same color as raceway. Coordinate color with Architect.
- G. Receptacles and outlets shown on raceway on drawings shall be mounted with overlapping faceplates in the raceway and shall not be mounted in boxes unless specifically noted otherwise.
- H. WW-1; Surface metal raceway, metallic cover, minimum 4" opening, power / communication divider, minimum 7.5 square inch capacity.

1. Manufacturers

- a. Wiremold G4000/G4048
- b. Mono-Systems SMS4200

- c. Hubbell HBL4750 Series.

PART 3 - EXECUTION

3.1 INSTALLATION - SURFACE METAL RACEWAY AND MULTI-OUTLET ASSEMBLY

- A. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.
- B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- C. Maintain grounding continuity between raceway components to provide a continuous grounding path.
- D. Fastener: Use clips and straps suitable for the purpose.
- E. Field cuts to be clean and straight and use the proper tools as recommended by the system manufacturer to prohibit damage to factory finish or raceway. Joints to be matched so there are no gaps or spaces in the cover. Furnish and install manufacturer's raceway accessories as needed.
- F. Provide conduits to technology raceway per drawings or provide a minimum of one (1) 1-1/4" conduit per six feet of assembly (minimum 2) to above ceiling for technology requirements if assembly has technology raceway (Contractor shall provide quantities of conduits that provide maximum capacity to assembly). Provide conduits equally spaced within entire length of assembly.
- G. Provide one (1) 3/4" empty conduit per six feet of assembly (minimum 1) to above ceiling for future power needs. Provide conduits equally spaced within entire length of assembly.

END OF SECTION

SECTION 260548 - SEISMIC REQUIREMENTS FOR EQUIPMENT AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Seismic Requirements.

1.2 QUALITY ASSURANCE

A. General:

1. The contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint and support system and perform seismic calculations in accordance with these specifications, state, and local codes.
2. Items used for seismic restraint of equipment and systems shall be specifically manufactured for seismic restraint.
3. These requirements are beyond those listed in Section 260527 of these specifications. Where a conflict arises between the seismic requirements of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this Section.
2. Equipment: Each company providing equipment that must meet seismic requirements shall provide certification included in project submittals the equipment supplied for the project meets or exceeds the seismic requirements of the project.

C. Testing Agency: An independent testing agency, acceptable to Authorities Having Jurisdiction, with experience and capability to conduct the testing indicated.

D. Installer: Company specializing in performing the work of this Section.

1.3 REFERENCES

- A. Arkansas Building Code, 2021.
- B. ASHRAE - A Practical Guide to Seismic Restraint.
- C. Technical Manual 5-809-10, NAVFAC P-355, Air Force Manual 88-3, Chapter 13.
- D. ASCE 7-16, Chapter 13.

1.4 SUBMITTALS

- A. Submit under provisions of Section 260500.

B. Shop Drawings:

1. Calculations, restraint selections, and installation details shall be designed and sealed by a Professional Engineer licensed in the state where the project is located experienced in seismic restraint design and installation.
2. Coordination Drawings: Plans and sections drawn to scale, coordinating seismic bracing of electrical components with other systems and equipment in the vicinity, including other seismic restraints.
3. Manufacturer's Certifications: Professional Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
4. System Supports/Restraints - Submit for each condition requiring seismic bracing:
 - a. Calculations for each seismic brace and detail utilized on the project.
 - b. Plan drawings showing locations and types of seismic braces on contractor fabrication/installation drawings.
 - c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
 - d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.
5. Equipment - Submit for each piece of equipment supplied:
 - a. Certification that the equipment supplied for the project meets or exceeds the seismic requirements specified. Equipment certification is to be provided by the manufacturer
 - b. Specific details of seismic design features of equipment and maximum seismic loads imparted to the structural support.
 - c. Engineering calculations and details for equipment anchorage and support structure.

- C. A seismic restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If seismic restraints are not provided for a system that requires seismic bracing, the seismic designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, utilized for each item. Seismic designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance to the exception.

1.5 TESTING AND INSPECTION

- A. Special Inspection and Testing shall be done in accordance with Chapter 17 of the International Building Code.
- B. The Owner shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.

- C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.
- D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

1.7 DESIGN REQUIREMENTS

- A. This project is subject to the seismic bracing requirements of the International Building Code, 2021 edition.
- B. The following criteria are applicable to this project:
 - 1. Risk Category: IV
 - 2. Seismic Importance Factor: $I_E = 1.25$
 - 3. Seismic Design Category: D
 - 4. Component Amplification Factors (a_p) and Component Response Modification Factors (R_p) shall be taken from Table 13.5-1 in ASCE 7-16 for the individual equipment or system being restrained.
 - 5. Component Importance Factors (I_p) shall be taken from Section 13.1.3 in ASCE 7-16 for the individual equipment or system being restrained.
 - 6. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.
- C. Forces shall be calculated with the above requirements and Equation 13.3-1, -2, and -3 of ASCE 7-16, unless exempted by 13.1.4.
- D. Equipment shall meet International Building Code and ASCE 7 seismic qualification requirements in concurrence with ICC ES AC156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.
- E. All seismic anchorage and bracing shall comply with FM Global Property Loss Prevention Data Sheet 1-11, Fire Following Earthquakes.

1.8 COORDINATION

- A. Coordinate layout and installation of seismic bracing with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

1.9 WARRANTY

- A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SUPPLIERS

- A. Following is a partial list of manufacturer/supplier contact information for seismic restraints:

1. B-Line Systems, Inc. (800) 851-7415, www.b-line.com.
2. Unistrut Corporation <http://www.unistrut.us/>
3. Kinetics Noise Control (877) 457-2695, www.kineticsnoise.com.
4. Mason Industries, Inc. www.mason-ind.com.
5. Loos & Co., Inc. (800) 321-5667, www.loosnaples.com.
6. Tolco (909) 737-5599, www.tolco.com
7. ISAT 877.523.6060, www.isatsb.com
8. Vibro-Acoustics (416) 291-7371, <https://virs.vibro-acoustics.com/>

2.2 SEISMIC DESIGN CRITERIA

- A. This section describes the requirements for seismic restraint of systems and equipment related to continued operation of the facility after a design seismic event.
- B. Definitions:
 1. Stay in Place:
 - a. All systems and equipment shall be anchored and restrained such that the anchoring system is intended not to fail and equipment and/or system components will not fall.
 2. Remain Operational:
 - a. Requirements for "Stay in Place" listed above shall be met.
 - b. The following systems and associated equipment are intended not to fail externally or internally and are intended to continue operation following a seismic event:
 - 1) Life Safety Power
 - 2) Emergency Power System
 - 3) Fire Alarm

2.3 SEISMIC BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Seismic restraint designer shall coordinate all attachments with the Structural Engineer of Record; refer to submittal requirements.
2. The seismic restraint design shall be based on actual equipment data obtained from manufacturer's submittals or the manufacturer. The equipment manufacturer shall verify and provide written certification the attachment points on the equipment can accept the combination of seismic, weight, and other imposed loads.
3. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
4. Analysis shall detail anchoring methods, bolt diameter, embedment, and weld length.
5. All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code.
6. All seismic restraints and combination isolator/restraints shall have verification of their seismic capabilities witnessed by an independent testing agency.

B. Friction from gravity loads shall not be considered resistance to seismic forces.

2.4 SEISMIC RESTRAINT AND CONSTRUCTION OF EQUIPMENT

- ### A. Equipment supplied for the project shall be designed to meet the requirements of lateral forces calculated using the applicable code and method described above.
- ### B. The following is a partial list of equipment that shall be restrained and that shall be constructed to meet seismic forces described in this section:

1. Switchboards, Distribution Panelboards, Panelboards, Load Centers
2. Emergency Feeders
3. Disconnect Switches
4. Variable Frequency Drives
5. Interior Luminaires
6. Emergency Luminaires and Exit Signs
7. Fire Alarm Panel, Initiating and Notification Appliances
8. Nurse Call
9. Intercom, Sound System, Clock, TV Distribution
10. Security System

2.5 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.
3. Corrosive Locations: Stainless steel.

2.6 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

- A. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
- B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with IBC, ACI and ICC ES requirements for cracked concrete anchors.
- C. Concrete Inserts: Steel-channel type.
- D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125, Grade A 325.
- E. Welding Lugs: Comply with MSS SP-69, Type 57.
- F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.
- G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.7 SEISMIC BRACING COMPONENTS

- A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inchthick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.
 - 1. Materials for Channel: ASTM A 1011, GR 33.
 - 2. Materials for Fittings and Accessories: ASTM A 635, ASTM A 576, or ASTM A 36.
 - 3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
 - 4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.
- B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.

- C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.
 - 1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
 - 2. Wire Rope Cable: Comply with ASTM A 603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.
- D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to the applicable code sections and Authority Having Jurisdiction for the exact seismic restraint requirements of conduit, equipment, etc.
- B. Layout of transverse and longitudinal bracing shall follow recommendations of approved design standards listed in Part 1 of this specification section.
- C. All rigid floor mounted equipment shall have a resilient media between the equipment mounting hole and the anchor bolt in concrete.
- D. All seismic restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
- E. Installation of seismic restraints shall not cause any change in position of equipment lighting or conduits resulting in stresses or misalignment.
- F. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.
- G. Do not install any equipment or conduit that makes rigid connections with the building unless isolation is not specified.
- H. Coordinate work with all other trades to avoid rigid contact with the building. Any conflicts with other trades that will result in rigid contact with equipment or conduit due to inadequate space or other unforeseen conditions shall be brought to the Architect/Engineer's attention prior to specific equipment selection.
- I. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
- J. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or International Code Council approved seismic anchors for installation in concrete.

- K. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment or conduit.
 - L. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.
 - M. Do not install cables over sharp corners.
 - N. Brace support rods when necessary to accept compressive loads. Welding of compression braces to the vertical support rods is not acceptable.
 - O. Provide reinforced clevis bolts when required.
 - P. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.
 - Q. Post-Installed anchors shall be provided to meet seismic requirements.
 - R. Vertical conduit risers flexibly supported to accommodate thermal motion and/or conduit vibration shall be guided to maintain conduit stability and provide horizontal seismic restraint.
 - S. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.
 - T. Conduit crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the conduit, equipment connections, or support connections. Conduit offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent conduit.
 - U. Do not brace a system to two different structures such as a wall and a ceiling.
 - V. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.
 - W. Positively attach all roof-mounted equipment to roof curbs. Positively attach all roof curbs to building structure.
 - X. Exposed seismic supports in occupied areas shall be guarded or covered to protect occupants.
- 3.2 SEISMIC RESTRAINT EXCLUSIONS
- A. Refer to the applicable code sections and Authority Having Jurisdiction for allowable exclusions.

END OF SECTION

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Adhesive Markings and Field Labels
- B. Nameplates and Signs
- C. Product Colors

1.2 RELATED SECTIONS AND WORK

- A. Section 260500 - Basic Electrical Requirements

1.3 REFERENCES

- A. NFPA 70E - Standard for Electrical Safety in the Workplace
- B. NFPA 70 - National Electrical Code (NEC)
- C. ANSI A13.1 - Standard for Pipe Identification
- D. ANSI Z535.4 - Standard for Product Safety Signs and Labels

1.4 QUALITY ASSURANCE

- A. Electrical identification products shall be suitable for the environment installed. Identification labels damaged by the environment due to ultraviolet light fading, damp or wet conditions, physical damage, corrosion, or other conditions shall be replaced with labels suitable for the environment.

1.5 SUBMITTALS

- A. General: Submit the following in accordance with Division 1 Specification Sections and under provisions of Section 260500.
 - 1. Product Data for each type of product specified.
 - 2. Schedule of nomenclature to be used for identification signs and labels for each piece of equipment including, but not limited to, the following equipment types as specified in Division 26.
 - 3. Samples of each color, lettering style and other graphic representation required for identification materials including samples of labels and signs.
 - 4. Identification required in this section shall apply to equipment furnished in Division 26 and any other applicable Divisions including Division 21/22/23.

PART 2 - PRODUCTS

2.1 ADHESIVE MARKINGS AND FIELD LABELS

- A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).
 - 1. Label Size as follows:
 - a. Raceways: Kroy or Brother labels 1-inch high by 12-inches long (minimum).
 - 2. Color: As specified for various systems.
- B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- C. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.
- D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from -40°F to 185°F (-40°C to 85°C), type 2/2S or type 21/21S based on application. Provide ties in specified colors when used for color coding. Cable ties shall be listed and identified for the application, securement, and support.
- F. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.
- G. Aluminum, Wraparound Marker Bands: 1-inch width, 0.014 (5mm) inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- H. Brass or Aluminum Tags: 2" (50mm) by 2" (50mm) by .05-inch metal tags with stamped legend, punched for fastener.
- I. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.
- J. Text Sizes:
 - 1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
 - a. Font: Normal 721 Swiss Bold
 - b. Adhesive Labels: 3/16 inch minimum text height
 - c. Vinyl / Plastic Laminate Labels: 3/4" inch minimum text height

2.2 NAMEPLATES AND SIGNS

- A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners.
- B. Text Sizes:
 - 1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
 - a. Text Height: 3/8 inch minimum
- C. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch galvanized-steel backing; and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- E. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- F. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.3 PRODUCT COLORS

- A. Adhesive Markings and Field Labels:
 - 1. Normal Power and General Labels: Black letters on white face
 - 2. Control Labels: Black letters on white face
 - 3. Medium Voltage (greater than 1,000 volts): Black letters on white face
 - 4. Fire Alarm: White letters on red face
 - 5. Emergency: White letters on red face
- B. Nameplates and Signs:
 - 1. NORMAL POWER: Black letters on white face
 - 2. Control Labels: Black letters on white face
 - 3. EMERGENCY: White letters on red face
 - 4. GROUNDING: White letters on green face.
 - 5. CAUTION or UPS: Black letters on yellow face
- C. Raceways and Conduit:
 - 1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
 - a. Normal Power and General Distribution: Silver

- b. Emergency Power Distribution System:
 - 1) Life Safety and Critical Branch: Silver
 - 2) Equipment Branch: Silver
 - c. Fire Alarm System: Red
 - d. Temperature Controls: Refer to mechanical cover sheet for color
 - e. Ground: Silver
 - f. Low Voltage and Telephone: Silver
 - g. Clock, Sound, Security System, and Intercom: Silver
 - h. Nurse Call: White
- D. Box Covers:
- 1. Box cover colors shall match conduit colors listed above.
- E. Conductor Color Identification: Refer to Part 3 for additional information.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.
- B. Exposed Ceilings and Finished Spaces: The project includes exposed ceilings in finished spaces. The installation of colored raceways and labeling may not be aesthetically desirable in finished spaces. The contractor shall coordinate identification requirements in exposed ceilings of finished spaces with the Architect/Engineer prior to installation and ordering of materials.
- C. Install identification devices in accordance with manufacturer's written instruction and requirements of Electrical Code.
- D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.
- E. Circuit Identification: Tag or label conductors as follows:
 - 1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
 - 2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.

3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- F. Apply Danger, Warning, Caution and instruction signs as follows:
1. Install Danger, Warning, Caution or instruction signs where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. 'Danger' indicates a hazardous situation which, if not avoided, will result in death or serious injury. ANSI standard red background, white letters.
 3. 'Warning' indicates a hazardous situation which, if not avoided, could result in death or serious injury. ANSI standard orange background, black letters.
 4. 'Caution' indicates a hazardous situation which, if not avoided, may result in minor or moderate injury. ANSI standard yellow background, black letters.
 5. Emergency Operating Signs: Install, where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- G. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.
- H. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- I. Install ARC FLASH WARNING signs on all switchboards, switchgear, distribution panels, branch panelboards, industrial control panels, and motor control centers.
1. Sample Label:

! WARNING
ARC FLASH AND SHOCK HAZARD
APPROPRIATE PPE REQUIRED
FAILURE TO COMPLY CAN RESULT IN DEATH OR INJURY
REFER TO NFPA 70E
- J. Circuits with more than 600V: Identify raceway and cable with "DANGER-HIGH VOLTAGE" in black letters 2 (50mm) inches high on orange background at 10'-0 foot intervals.
1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.

2. Wall surfaces directly external to conduits concealed within wall.
 3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.
- K. Selective Coordination Label: Install caution signs on all switchboards, distribution panels, panelboards, disconnects, and other equipment with selectively coordinated overcurrent protection devices. Sign at a minimum shall contain:
1. CAUTION: OVERCURRENT DEVICES IN THIS ENCLOSURE ARE SELECTIVELY COORDINATED. EQUIVALENT REPLACEMENTS AND TRIP SETTINGS ARE REQUIRED.
- L. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 (150mm) to 8 (205mm) inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches; provide a second plastic line marker to mark each edge of the trench when 16 inches of width is exceeded. Install line marker for underground wiring, both direct-buried cables and cables in raceway.
- 3.2 FEEDER AND BRANCH CIRCUIT DIRECTORIES
- A. Product:
1. Adhesive labels and field markings
 2. Nameplates and signs
- B. Feeder Directories Branch: Provide each feeder, branch circuit, feeder modification, and branch circuit modification with a typed circuit directory label. Refer to technical equipment specification sections for additional requirements. Include the following with each label:
1. Load Description: Lighting, receptacles, specific equipment, spare, space, or similar description.
 2. Location: Room name, number, location.
- C. Provide a factory or custom clear plastic sleeve for each branch panel directory and secure to inside panel cover.

3.3 LIGHTING CONTROL AND RECEPTACLE COVER PLATES

- A. Product:
1. Adhesive labels and field markings
 2. Nameplates and signs
- B. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.

- C. Identification material to be engraved plastic-laminated labels, 1/16-inch minimum thickness with white letters on a red face. Letter and number size to 1/8-inch high.
- D. Identification to be engraved directly on the stainless steel coverplates. Letter and number size to 1/8-inch high.
- E. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. "C1A #24").

3.4 CONDUIT AND EXPOSED CABLE LABELING

- A. Product:
 - 1. Adhesive labels and field markings
- B. Conduit Identification: Pre-printed, flexible, self-adhesive vinyl labels with legend at 20 foot (6 meter) intervals to identify all conduits run exposed or located above accessible ceilings. Conduits located above non-accessible ceiling or in floors and walls shall be labeled within 3 feet of becoming accessible, or separated by enclosures, walls, partitions, ceilings, and floors. Labels for multiple conduits shall be aligned. Refer to color requirements in Part 2 when applicable in addition to the following:
 - 1. Medium Voltage (greater than 1,000 volt): Indicate feeder identification and voltage.
 - 2. 1000 Volt or less Normal/Emergency Power: Indicate feeder identification and voltage.
 - 3. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
 - 4. Fire Alarm: Indicate "FIRE ALARM".
 - 5. Grounding: Indicate "GROUND" and equipment and designation.
 - 6. Security System: Indicate "Security".
 - 7. Telephone System: Indicate "Telephone".
- C. Blank conduit ends or outlet boxes for future extension of system shall have permanent identification marker indicating purpose of conduit or box and where the raceway originated.

3.5 CONDUIT AND RACEWAY COLOR BANDING FOR EXISTING CONDITIONS AND REMODELING

- A. Existing Conduit and Raceways: Identify existing conduits and raceways within the limits of the project boundary with color banding.
 - 1. Existing conduit and raceways to be color banded: 3/4 inch and larger.
 - 2. The Contractor shall perform a review of the existing conduit, raceway, and system type prior to submitting a bid. The Contractor's review shall include a review of areas with non-finished ceilings and areas with accessible finished ceilings.

- B. New Conduit and Raceways: Identify new conduits and raceways with color banding. The following products and materials shall be identified with color banding when required by Part 1 of this specification.

1. Rigid metallic conduit and fittings (RMC)
2. Intermediate metallic conduit and fittings (IMC)
3. Reinforced thermosetting resin conduit (RTRC)
4. Phenolic reinforced thermosetting resin conduit (phenolic RTRC conduit)
Example: Fire-rated cable and assemblies
5. Wire and cable installed with or without raceways:
 - a. Fire-rated cable and assemblies (including but not limited to MI, fire-rated MC)
 - b. Healthcare facilities cable (HFC)
 - c. Armored cable (AC)
 - d. Metal-clad cable (MC)
 - e. Low voltage cabling

- C. Instructions:

1. Band exposed or accessible raceways, cables, and bare conductors. Bands shall be pretensioned, snap-around colored plastic sleeves, colored adhesive marking tape, or a combination of the two. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Refer to Part 1 of this specification for specific systems and colors requiring banding.
2. Install bands at changes within 36 inches of direction changes, all wall/floor penetrations, at each junction box, and at 10-foot maximum intervals in straight runs.

3.6 BOX LABELING

- A. Products:

1. Adhesive labels and field markings

- B. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch Kroy tape OR Brother self-laminating vinyl label, letters/numbers color coded same as conduits. In rooms that are painted out, provide labeling on inside of cover.

- C. All junction, pull, and connection boxes shall be identified as follows:

1. For power and lighting circuits, indicate system voltage and identity of contained circuits ("120V, 1LA1-3,5,7").
2. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
3. For other wiring, indicate system type and description of wiring ("FIRE ALARM NAC #1").

3.7 CONDUCTOR COLOR CODING

A. Products:

1. All wire and cables shall be color coded by the manufacturer.

B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.

C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.

D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.

E. Conductors shall be color coded as follows:

1. 208Y/120 Volt, 4-Wire:

- a. A-Phase - Black
- b. B-Phase - Red
- c. C-Phase - Blue
- d. Neutral - White
- e. Ground Bond - Green

2. 480Y/277 Volt, 4-Wire:

- a. A-Phase - Brown
- b. B-Phase - Orange
- c. C-Phase - Yellow
- d. Neutral - Gray
- e. Ground Bond - Green

3. Grounding Conductors:

- a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.
- b. Isolated Equipment Ground Conductors: Green with colored distinctive yellow stripe along the entire length of the conductor. Isolated ground for feeders, use colored tape with alternating bands of green and yellow to provide a minimum of three bands of green and two bands of yellow.

4. Cabling for Remote Control, Signal, and Power Limited Circuits:

- a. Fire Alarm: Red.
- b. Low Voltage Switching: Per manufacturer recommendations and code requirements.

- c. Building Automation Systems and Control: Refer to the Temperature Control Contactor notes located on the mechanical cover sheet.
- d. Nurse Call: Refer to Division 27.
- e. Electronic Control: Per manufacturer recommendations and code requirements.
- f. Audio/Visual Systems: Refer to Division 27.
- g. Structured Cabling: Refer to Division 27.

3.8 CONTROL EQUIPMENT IDENTIFICATION

A. Products:

- 1. Nameplates and signs

B. Provide identification on the front of all control equipment such as combination starters, starters, VFDs, contactors, motor control centers, etc.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.

D. Labeling shall include:

- 1. Equipment type and contract documents designation of equipment being served.
- 2. Location of equipment being served if it is not located within sight.
- 3. Voltage and phase of circuit(s).
- 4. Panel and circuit number(s) serving the equipment.
- 5. Method of automatic control, if included ("AUTO CONTROL BY FMCS").
- 6. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
- 7. Date of fault current study, refer to one-line diagram
- 8. Sample Label:

EXHAUST FAN EF-1 ("LOCATED ON ROOF")
480V, 3-PHASE
FED FROM "1HA1-1"
AUTO CONTROL BY FMCS
22,000 AMPS AVAILABLE FAULT CURRENT
DATE OF STUDY: 1 JAN 2017

3.9 EQUIPMENT CONNECTION IDENTIFICATION

A. Products:

- 1. Nameplates and signs

B. Provide identification for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.

- C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner. The following list of equipment is specifically being listed to receive an equipment connection label; this list does not limit the equipment that shall receive a label:

1. Mechanical heating, ventilation, and air conditioning equipment; chillers, boilers, pumps, air handling ventilation units, condensing units, unit heaters, and similar equipment
2. Plumbing equipment
3. Fire protection equipment including fire pumps
4. Medical gas equipment and equipment skids

- D. Labeling shall include:

1. Equipment type and contract documents designation of equipment being served
2. Location of equipment being served if it is not located within sight.
3. Voltage and rating of the equipment.
4. Panel and circuit numbers(s) serving the equipment
5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
6. Date of fault current study; refer to one-line diagram
7. Sample Label:

UNIT HEATER UH-1 ("LOCATED IN STORAGE ROOM 200")
480V: 3-PHASE
FED FROM "1HA1-1"
22,000 AMPS AVAILABLE FAULT CURRENT
DATE OF STUDY: 1 JAN 2017

3.10 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

- A. Products:

1. Nameplates and signs

- B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.

1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.
2. Exterior Equipment: The identification material shall be engraved vinyl labels.
3. Labeling shall include:
 - a. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Applicable equipment includes components of the life safety and critical branch for healthcare facilities (generators, transfer switches, switchboards, distribution panels, panelboards, etc.).

- b. Equipment type and contract documents designation of equipment.
- c. Voltage of the equipment.
- d. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
- e. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").
- f. Sample Label:

DISTRIBUTION PANEL DP-H1
480Y/277V
FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELEC ROOM)

4. Provide the following on a separate label, installed below the label above:

- a. Available fault current; refer to one-line diagram or panel schedules
- b. Date of fault current study; refer to one-line diagram
- c. Sample Label:

22,000 AMPS AVAILABLE FAULT CURRENT
DATE OF STUDY: 1 JAN 2017

C. Adjustable-Trip Over Current Protection Label:

1. Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with adjustable trip settings. Provide label separate from load identification label.

- a. Label:

- 1) Long-time delay:
- 2) Long-time pickup:
- 3) Short-time delay:
- 4) Short-time pickup:
- 5) Instantaneous:
- 6) Ground fault delay:
- 7) Ground fault:

- b. Sample Label:

Long-time delay: 10.0
Long-time pickup: 1.0
Short-time delay: 0.15
Short-time pickup: 5.0
Instantaneous: 2.0
Ground fault delay: 0.25
Ground fault: 50.0

D. Nominal System Voltage Label:

1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

E. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1"). Provide a separate engraved plastic laminate label adjacent to each overcurrent protection device with feeder wire size, feeder wire quantity, conductor material and distance in feet. Provide label separate from load identification label and adjustable trip settings label.

1. Sample Labels for Feeders:

4#3/0 CU & 1#6 CU GND, 125FT
4#250KCM AL & 1#6 GND CU, 125FT
2 SETS 4#400KCM CU & 1#1 GND CU, 125FT

F. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 260500 for other requirements.

END OF SECTION

SECTION 260801 - COMMISSIONING OF ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Description
- B. Responsibilities
- C. Related Work
- D. Test Equipment

1.2 DESCRIPTION

- A. The purpose of this section is to specify Division 26 responsibilities in the commissioning process.
- B. The systems to be commissioned are the electrical lighting systems listed in IECC 2009 Section C408 applicable to the project.
 - 1. Lighting and Lighting Controls

1.3 RESPONSIBILITIES

- A. Commissioning requires the participation of the Division 26 Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 019101. Division 26 Contractor shall be familiar with all parts of Section 019101 and shall execute all commissioning responsibilities assigned to them in the Contract Documents.
- B. Refer to Section 019101 for more information.

1.4 RELATED WORK

- A. Specific commissioning requirements are given in the following sections of these specifications. All the following sections apply to the Work of this section.
 - 1. Section 017823 - Operations and Maintenance
 - 2. Section 017900 - Demonstration and Training
 - 3. Section 019101 - Commissioning
 - 4. Section 220801 - Commissioning of Plumbing
 - 5. Section 230801 - Commissioning of HVAC

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall provide all test equipment necessary to fulfill the testing requirements of this Division. This equipment includes, but is not limited to, the following:
 - 1. Light meter.
 - 2. Digital multimeter capable of measuring voltage (AC/DC), current, and resistance.
- B. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the related specifications. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.
- C. Refer to Section 019101 for additional Division 26 requirements.

PART 3 - EXECUTION

- A. Refer to Section 019101 for additional information.

END OF SECTION

SECTION 260933 - LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Lighting Control Overview
- B. Electrical Plan Symbols
- C. Device Color and Coverplates
- D. Standalone Line and Low Voltage Lighting Controls
 - 1. Wall switches and wall dimmers
 - 2. Sensors (occupancy, vacancy, daylighting, photocell, auxiliary power packs, etc.)
- E. Room-Based Lighting Controls (specification grade, commonly distributed controllers, occasionally networked, 'intelligent' controls)
- F. *Nurse Call Lighting Controller (SW-NLC)*
- G. *Automatic Load Control Relays*
 - 1. Automatic Load Control Relay (ALCR20)

1.2 RELATED SECTIONS

- A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of directly comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:
 - 1. Specification Section 262416 Panelboards (panelboard enclosure and interior bussing used for lighting control panels)
 - 2. Specification Section 262821 Contactors
 - 3. Specification Section 265119 LED Lighting
 - 4. Specification Section 265215 Emergency Lighting Inverter
 - 5. Electrical Drawings: Electrical Coversheet, plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

1.3 RELATED WORK

- A. Section 019100 - Commissioning
- B. Section 230923 - Direct Digital Control System for HVAC Interface of Lighting Controls with HVAC Controls
- C. Section 274100 - Audio/Visual System

1.4 QUALITY ASSURANCE

- A. Manufacturers shall be regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. All components and assemblies are to be factory pre-tested prior to delivery and installation.

1.5 REFERENCES

- A. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference
- B. FS W S 896 Switch, Toggle
- C. International Energy Conservation Code (IECC)
- D. NEMA WD 1 - General Color Requirements for Wiring Devices
- E. NEMA WD 7 - Occupancy Motion Sensors
- F. NFPA 70 - National Electrical Code (NEC)
- G. UL Standard 916 Energy Management Equipment
- H. UL 924 - Emergency Lighting and Power Equipment
- I. UL 20 - Standards for General-Use Snap Switches
- J. UL 98 - Enclosed and Dead-Front Switches
- K. UL 917 - Clock Operated Switches
- L. UL 1008 - Transfer Switch Equipment
- M. UL 1472 - Solid-State Dimming Controls

1.6 SUBMITTALS

- A. Submit product data under provisions of Section 260500.

- B. Submit a comprehensive package including devices, hardware, software, product specification, finishes, dimensions, installation instructions, component replacement instructions, warranty, system software requirements.
 - C. Provide floor plan showing location, orientation, and coverage area of each control device, sensor, and controller/interface. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer-approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form. Sensor coverage patterns shall have a 20% overlap.
 - D. Submit a list of devices and equipment that will be installed for each sequence of operation.
 - E. Submit project specific control wiring diagrams showing all equipment, line voltage, and control wiring requirements for all components including, but not limited to, dimmers, relays, low voltage switches, automatic sensors, control stations, and communication interfaces and programming instructions for each sequence of operation. Include network cable specification and end-of-line termination details, if required.
 - F. Programming Sequences: Provide a copy of the initial lighting control programming sequences in narrative and manufacturer/vendor format.
 - G. Lighting Control Stations: The manufacturer/vendor shall provide control station shop drawings showing arrangement of controls, dimensioned elevations, wiring diagram, and recommended backboxes. Label each applicable submittal with the applicable Sequence Of Operation SOO description. Submit data sheets on the switches, dimmers, sensors, buttons, etc. contained in the control station.
 - H. Nameplate Labels and Custom Engraving: Submit sample label/engraving text for review for each applicable Lighting Sequence Of Operation SOO. Include reference to applicable SOO description. Provide stencil templates for each device requiring stenciling.
 - I. Coordinate integration with mechanical and/or other trades.
 - J. Network / Internet Connected Equipment: These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ('Network Capability'). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be constructed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner. Provide Owner written consent and instructions as a submittal.
- 1.7 EXTRA STOCK
- A. Provide extra stock under provisions of Section 260500.
 - B. Sensors, Controls, Power Supplies, and Relays: Five (5) percent of quantity installed. Minimum of two (2) of each configuration and type.

- C. Relays and Dimmer Modules: Five (5) percent of quantity installed. Minimum of two (2) of each size and type.
- D. Control Stations: One (1) of each configuration and type, except for LCD (SW-LDC) touch screens and portable PCS (SW-PCS) control stations requiring factory setup prior to installation.
- E. Handheld Lighting Control Programming Stations: Provide two (2) lighting control programming stations when a proprietary controller is available and applicable to the specific lighting control system.
- F. Commissioning Dongles: Provide ten (10) spare commissioning dongle devices for room controller, sensor, and relay programming when applicable to the specific lighting control system.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit project record documents under provisions of Section 260500.
- B. Accurately record location of all controls and devices. Include description of switching sequences and circuiting arrangements.

1.9 OPERATION AND MAINTENANCE DATA

- A. Submit emergency, operation, and maintenance data under provisions of Section 260500. Data shall also include the following:
 - 1. Schedule for routine maintenance, inspection, and calibration of all lighting control devices and system components. Recommended schedule for inspection and recalibration of sensors.
 - 2. Complete narrative describing intended operation and sequence for each control scenario and system component, updated to reflect all changes resulting from commissioning of systems. Narrative shall indicate recommended settings for devices where applicable.
 - 3. Replacement part numbers for all system components.
- B. Identify installed location and labeling for each luminaire controlled by automated lighting controls.
- C. Submit software operating and maintenance manuals, program software backup on compact disc or compatible media with data files, device address list, and a printout of software application and graphic screens, where applicable.

1.10 SYSTEM DESCRIPTION

- A. Performance Statement: The specification section and lighting design documents describe the minimum material quality, required features, and operational performance requirements of the lighting control system. The documents do not convey every component, relay, wire, and equipment connection required. The Contractor and lighting control manufacturer/vendor are solely responsible for determining all system components, wiring, and programming required for a complete and operational system based on the performance based requirements of the documents.
- B. Lighting Sequence Of Operation (SOO): The Sequence Of Operation (SOO) describes the required lighting control operation and performance in each space. The Sequence Of Operation descriptions are included on the drawings.
- C. Drawings: The drawings include the Sequence Of Operation (SOO), luminaire schedule, location of control devices, sensors, and identification of control zones, and branch power circuiting. Control wiring and manufacturer/vendor specific components are NOT shown, but shall be submitted with the shop drawing submittals.
- D. Extending the Existing Lighting Control System: Provide all items, components, devices, hardware, software, programming, expansion components, conduit, wiring etc. needed to extend the existing Lighting Control system. This includes, but is not limited to, additional room controllers, network controllers, individual system components, power supplies, etc. The existing lighting control system shall be extended with the new lighting control system such that the existing system's functionality, integrity, control sequences, master control stations, etc shall be equivalent to pre-construction conditions, unless noted otherwise. The functionality and integrity shall be maintained during construction.

1.11 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative Architect/Engineer and the Commissioning Agent. Project closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 1 for detailed commissioning requirements.
- B. The Contractor shall provide all services necessary for compliance with the IECC Section C408 Commissioning. The commissioning shall include, but not be limited to, a commissioning plan, preliminary commissioning report, construction documents, manuals, final commissioning report, and lighting system functional testing.
- C. This project will have selected building systems commissioned. The Contractor is responsible to execute commissioning. The commissioning process, equipment, and systems to be commissioned are defined in Division 1.
- D. The Contractor shall notify the Commissioning Agent, Architect/Engineer and Owner's Representative ten (10) working days prior to scheduled commissioning date.

- E. The commissioning process requires meeting attendance. Refer to Division 1 for meeting requirements.
- F. The system shall be functionally tested by a factory-authorized engineer and comply with the Sequence of Operation prior to system commissioning. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system.

1.12 WARRANTY

- A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of commissioning.
- B. Automatic (occupancy, vacancy), daylight sensors, and controls shall have a five (5) year warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LIGHTING CONTROL OVERVIEW

- A. Lighting Control System: As defined in the System Description, the design documents describe the operational performance requirements of the lighting control system. The Lighting Control System has been categorized into the following groups. Refer to the Electrical Symbol Key, this specification section, and the drawings to determine the appropriate lighting control category when more than one is applicable to the project:
 - 1. Standalone Lighting Control Devices: Independent (standalone) devices traditionally operating at line or low voltage, field configurable with other standalone devices to provide an overall lighting control system.
 - 2. Room-Based Lighting Controls: Integrated system comprised of switch stations, sensors, room controllers, control panels, and accessories, operating at line and/or low voltage, configured as an integrated overall 'intelligent' lighting control system. Lighting control zones and power circuits commonly align.
 - 3. Theatrical Lighting Controls: Not covered in this specification. Lighting control system commonly associated with theatrical productions, performances, and large scale venues.
- B. All system components and materials of similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications. Lighting control switches, systems, and components shall be listed.
- C. The functions described in the lighting sequence of operation shall dictate the actual lighting control device required to accomplish the functions described for the space, unless otherwise noted.

- D. Emergency Lighting Override Control (UL924 and UL1008): Lighting Control Equipment coupled with remote emergency power sources (external to the luminaire) require ALCR (UL924) or BCE LTS (UL1008) devices for emergency (life safety) compliance. An emergency lighting control bypass is required for every individual lighting control zone-circuit but NOT shown on the plans. Refer to this specification for ALCR and BCE LTS descriptions. Refer to the sequence of operation lighting control descriptions on the plans for additional requirements. (For additional explanation purposes: Integral emergency power sources like battery drivers inside the luminaire are commonly provided with a switch and non-switched portion of the circuit allowing compliance without an ALCR nor BCE LTS device to bypass the lighting controls).

2.2 ELECTRICAL PLAN SYMBOLS

- A. Refer to Electrical Coversheet for Electrical Symbols list and device specification tag.
1. Standalone Lighting Control Devices: Control station commonly defined by an alpha character with subscripts.
 - a. Example symbol "S", tagged "SW-1P", description "switch- single pole switch".
 - b. Example Control Designation: a, b, c (when required to clarify design intent).
 2. Room-Based Lighting Controls: Control station commonly defined by a rectangle symbol.
 - a. Example Control Station: symbol "#B", tagged "SW-LV", description "Lighting Control Station".
 - b. Example Panel/Rack/Cabinet: tagged "LCPR#", description Room-Based lighting control panel/rack/cabinet.
 - c. Example Control Designations: a, b, c
 3. Sensors, Relays, Accessories: Common plan symbols are used for automatic (occupancy, vacancy), and daylighting sensors. The control designations (a, b, c) and identification of a standalone or #B type control station in the space defines the basis-of-design intent category of the lighting control sensors and accessories.
 - a. Example, a standalone automatic sensor SW-OC-## or SW-VC-## device is the basis of design when shown in the same room as a standalone S (SW-1P) single pole light switch with or without a, b, c control designations.
 - b. Example, a Room-Based Lighting automatic sensor SW-OC-## or SW-VC-## device is the basis of design when shown in the same room as a #B (SW-#B) lighting control station with or without a, b, c control designations.

2.3 DEVICE COLOR AND COVERPLATES

- A. All switches and lighting controls shall be complete with coverplates that match material and color of the wiring device coverplates in the space. When the coverplate is proprietary to the device/manufacture and do not match the wiring device coverplates, the architect shall select the coverplate color and materials from the standard coverplate options.
- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 260553.
- D. Plate-securing screws shall be metal with head color matching the wall plate finish.
- E. Antimicrobial: Switch touch surfaces shall have an antimicrobial additive that suppresses the growth of harmful bacteria, mold, mildew, and fungi; color/material selection by architect.
 - 1. Manufacturers:
 - a. Cooper 7621 CuVerro
 - b. Leviton A5621
 - 2. Install antimicrobial switch and coverplates in the following areas:
 - a. Pharmacy
 - b. USP Rooms
 - c. Lab Rooms
- F. Where indicated on drawings, provide compatible wire guards for devices to protect against damage and vandalism. Wire guards shall be constructed of durable coated steel wire.

2.4 STANDALONE LINE AND LOW VOLTAGE LIGHTING CONTROLS

- A. Standalone Lighting Control System Description: The standalone lighting control system includes individual devices, components, and accessories for lighting controls.
- B. The lighting control system manufacturer shall be responsible to assure coordination and compatibility between all system devices, components, and accessories.
- C. Global System Typography: The system shall be provided with the following global system characteristics. When multiple exclusive options are listed the manufacturer/vendor may submit a system based on either criterion unless otherwise noted. When the drawings identify a specific option (typically identified with a subscript) provide the specific option as scheduled on the drawings.
 - 1. Automatic Sensor Control Devices, Component, and Accessories: Field adjustable Occupancy or Vacancy.

D. Overview:

1. Wall Switches and Wall Dimmers:

- a. UL listed with integral air-gap switch for on/off control, integral EMI/RFI suppression, non-viewable heat sink, dimmer to match device color.
- b. Dimmer compatibility and wiring with the load being controlled shall be verified by Contractor prior to purchase and installation.

E. SW-1P; Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
2. Manufacturers:
 - a. Hubbell HBL1221
 - b. Leviton 1221-2
 - c. Pass & Seymour PS20AC1
 - d. Cooper AH1221

F. SW-1P-EM; Emergency Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Red handle, side and back wired. Switch shall have with illuminated handle that is illuminated when load is off.
2. Manufacturers:
 - a. HBL1221R
 - b. Leviton 1221-2R
 - c. Pass & Seymour PS20AC1-RED
 - d. Cooper AH1221RD
3. Manufacturers:
 - a. Pass & Seymour 2625RED

G. SW-3W; Three-way Switch:

1. Single throw, 120/277 volt, 20 amp. Toggle handle, side and back wired.
2. Manufacturers:
 - a. Hubbell 1223
 - b. Leviton 1223-2
 - c. Pass & Seymour PS20AC3
 - d. Cooper AH1223

H. SW-3W-EM; Emergency Three-way Switch:

1. Single throw, 120/277 volt, 20 amp. Red toggle handle, side and back wired.
2. Manufacturers:
 - a. Hubbell 1223R

- b. Leviton 1223-2R
- c. Pass & Seymour PS20AC3-RED
- d. Cooper AH1223RD

I. SW-O; Dual Technology Automatic Sensor with Wall Switch (Standalone):

1. Wall switch with manual on/auto/off. 120/277 VAC load rating of 0-800 W for ballast, LED or tungsten. 5-, 15-, 20-minute adjustable OFF delay. Dual technology ultrasonic/acoustic and PIR coverage of minor motion in 12' x 15' pattern and occupancy detection in area based on half-step walking motion. Sensitivity adjustments separate for each sensing technology.
2. Manufacturers:
 - a. Watt Stopper DW-100 Series
 - b. Hubbell LHMTS
 - c. Leviton ODSMT Series
 - d. Sensor Switch WSX-PDT SA Series (acoustic approved when listed in above description)
 - e. Cooper OWN Series

J. SW-D; Dimmer (Standalone):

1. Contractor / vendor to provide dimmer based on rating required, compatible with wiring, lighting load being controlled. Verify compatibility with luminaire prior to light control prior to purchase and installation.
2. Electronic Driver Dimmer, 120 or 277 volt per application, 0-10 V control, decora style linear slide operator with positive off, IEC 60629 compliant. Mounted in dedicated backbox.
 - a. Manufacturers: Compatible with Luminaire Driver
3. Fluorescent Ballast Dimmer, 120 volt, linear slide operator with positive off, 16 amp minimum rating.
 - a. Manufacturers:
 - 1) Lutron NF-10
 - 2) Lightolier MP1500F
4. Alternative Dimmer, 120 or 277 volt per application, rating per application, linear slide operator with positive off. Mounted in dedicated backbox.
 - a. Manufacturers: Compatible with Luminaire Driver

K. SW-D3; Dimmer Three-Way (Standalone)

1. Contractor / vendor to provide dimmer based on rating required, compatible with wiring, lighting load being controlled. Verify compatibility with luminaire shop drawings prior to light control prior to purchase and installation. Three-way dimming with S3 three-pole toggle switch configuration.

2. Electronic Driver Dimmer, 120 or 277 volt per application, 0-10 V control, decora style linear slide operator with positive off, IEC 60629 compliant. Mounted in dedicated backbox.
 - a. Manufacturers: Compatible with Luminaire Driver
 3. Alternative Dimmer, 120 or 277 volt per application, rating per application, linear slide operator with positive off. Mounted in dedicated backbox.
 - a. Manufacturers: Compatible with Luminaire Driver
- L. SW-DO; Dimmer - Automatic Sensor Dual Technology (Standalone):
1. Contractor / vendor to provide dimmer based on rating required, compatible with wiring, lighting load being controlled. Verify compatibility with luminaire shop drawings prior to light control prior to purchase and installation.
 2. Occupancy Dimmer with manual on/auto/off, dual technology ultrasonic/acoustic and PIR120/277 volt on/auto/off, 0-10 V control. 120/277 V - 700 watt electronic ballast rated. Mounted in dedicated backbox.
 - a. Ratings/Manufacturers: Compatible with Luminaire Driver
 - 1) Lutron Maestro Series
 - 2) Acuity nLight Series
 - 3) Hubbell LightHawk Series
 - 4) Sensor Switch WSX D Series
 - 5) Cooper OSW/VSW Series
- M. SW-LS; Daylight Level Sensor and Controller (Standalone):
1. Contractor / vendor to provide daylight sensor based on sequence of operation requirements. Verify compatibility with luminaire shop drawings and luminaire driver prior to lighting control prior to purchase and installation.
 2. Subscripts: Subscripts are used to define the device type:
 - a. (BLANK) = Dimming Control
 - b. S = Switched Control
 - c. W = Wireless w/ Battery
 - d. # = Special Function
 3. Daylight level sensor, 120/277 volt, one or multi-zone per application, on/off/0-10 volt dimming control per application, 10-200 footcandle sensor range, adjustable deadband to prevent cycling and 0-30 minute adjustable time delay. Initial Settings: Refer to Sequence of Operation.
 4. Sensor shall detect changes in ambient light level and provide triggering of lighting groups in area based on sequence of operation.
 5. Sensor shall be configurable via DIP switches at device or via handheld wireless remote programming unit. Settings shall include:
 - a. Ambient sensitivity range between 10-200 foot-candles.
 - b. Time delay of 5 to 300 seconds.

- c. Trigger setpoints with deadband adjustment.
- 6. Sensor shall provide on/off setpoints in quantity as specified on drawings and as shown in the sequence of operation.
- 7. Sensor shall be ceiling- or wall-mounted for range and viewing angle meeting application requirements as outlined in the sequence of operation.
- 8. Output signal from sensor shall be linear with light level.
- 9. Manufacturers:
 - a. Watt Stopper LS-301 (dimming one zone)
 - b. Sensor Switch N-CMADC (dimming one zone)
 - c. Hubbell Automation DLC7 (dimming one zone)
 - d. Watt Stopper LCD-203/LS-290C (dimming three zone)
 - e. Sensor Switch N-CMADC (dimming three zone)
 - f. Hubbell Automation LUXSTATDCM/LUXSTATLS (dimming three zone)
 - g. LC&D Micro GR/2404 IDIM/Pcell (dimming three zone)
 - h. Watt Stopper LS-102 (on/off one zone)
 - i. Sensor Switch CM-PC (on/off one zone)
 - j. Hubbell Automation DLCPC Series (on/off one zone)
 - k. Cooper PPS-4 (on/off one zone)
 - l. Watt Stopper LCO-203/LS-290C (on/off three zone)
 - m. Sensor Switch N-CMPC (on/off three zone)
 - n. Hubbell Automation LUXSTATOCM/LUXSTATLS (on/off three zone)
 - o. LC&D Micro GR/2404 iDH/Pcell (on/off three zone)
- N. SW-OC-# and SW-VC-#; Automatic Sensors (Standalone):
 - 1. Combination Devices: Subscripts identify combination type devices when applicable. The contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device. Manufacturer verified layouts shall include a 20% overlap of coverage patterns.
 - 2. Subscripts: Subscripts are used to define the device type.
 - a. Blank (or D) = Dual Technology
 - b. A = Ultrasonic two-sided corridor coverage
 - c. P = Passive infrared
 - d. P2 = Passive infrared 100 degree coverage
 - e. U = Ultrasonic 360 degree coverage
 - f. HA = Highbay aisle coverage
 - g. HB = Highbay
 - h. W = Wireless with battery, 10 year minimum
 - 3. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.
 - a. Operation - Occupancy: Occupancy sensors turn lights 'on' when covered area is occupied and turn lights 'off' with a time delay when unoccupied, unless otherwise indicated.

- b. Operation - Vacancy: Vacancy sensors require a manual switch operation to turn lights 'on' with a time delay when occupied to turn lights 'off'.
- c. Time Delay 'Off': Field adjustable with a minimum range of 1-20 minutes.
- d. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
- e. Relay Unit: Dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13-amp tungsten at 120 VAC, and for 1 hp at 120 VAC. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by Electrical Code.
- f. Mounting:
 - 1) Sensor: Suitable for mounting in any position on a standard outlet box.
 - 2) Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.
 - 3) Time Delay and Sensitivity Adjustments: Recessed and concealed.
- 4. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.
- 5. Bypass Switch: Override the on function in case of sensor failure.
- 6. Power Supply and Child Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2" knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.
- 7. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.
- 8. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.
 - a. (A); Ultrasonic Two-Sided Corridor Coverage Automatic Sensor: Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
 - 1) Manufacturers:
 - a) Watt Stopper WT-2250 Series
 - b) Hubbell OMNI-US or ATU Series
 - c) Cooper OAC-U Series
 - b. Blank (or D); Dual Technology 360 Degree Coverage Automatic Sensor: Combination of PIR and ultrasonic or acoustic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit. Frequency greater than 40 KHz. Dual sensing verifications (requires both technologies to activate), either technology maintains on status. Integrated ambient light level sensor (2 to 200 FC range), adjustable sensitivity and time delay, integrated isolated relay contact. Sensor shall control all circuits in area, unless noted otherwise.

1) Manufacturers:

- a) Watt Stopper DT 300/200 Series
- b) Hubbell OMNI-DT2000 / LODTRP / ATD2000C Series
- c) Cooper OAC-DT Series
- d) Leviton OSC-MOW / OSM12 Series
- e) Sensor Switch CM PDT 10 / WvpDT 16 series (acoustic)

2.5 ROOM-BASED LIGHTING CONTROL SYSTEM ('INTELLIGENT CONTROLS)

- A. Manufacturers: Manufacturers as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.

- 1. Acuity Controls nLight Series
- 2. Cooper / Intelligent Lighting Controls ILC WaveLinX / EVO (room-based system) Series
- 3. Current Automation NX Series
- 4. Legrand Watt Stopper DLM Series
- 5. Lutron

- B. Room-Based Lighting Control System Description: The room-based lighting control system is a distributed network of devices, components, and accessories for lighting controls and integrated control with other systems. The system includes system room controllers (network hubs), control stations, sensors (occupancy, vacancy, daylighting, etc.), switching/dimming modules, programming, 365/7 day scheduling, and associated wiring.

- C. The lighting control system manufacturer shall be responsible to assure coordination and network compatibility between all system devices, components, and accessories.

- D. Global System Typography: The system shall be provided with the following global system characteristics. When multiple exclusive options are listed the manufacturer/vendor may submit a system based on either criterion unless otherwise noted. When the drawings identify a specific option (typically identified with a subscript) provide the specific option as scheduled on the drawings. (Example, a control station (SW-#B) shown with a "W" subscript on the plans shall be provided in a wireless configuration regardless if the following specification descriptions allow both low voltage or wireless network.)

- 1. System Controllers (Room Controllers): Room-based controllers located above accessible ceilings.
- 2. Interior Lighting Control System Network Connectivity for System Devices, Components, and Accessories: Low voltage cabling.
- 3. Exterior (Site) Lighting Control System Network Connectivity for System Devices, Components, and Accessories: Physical low voltage cabling.
- 4. Power Source for System Devices, Components, and Accessories: AC power pack supply.
- 5. Automatic Sensor Control Devices, Components, and Accessories: Field adjustable Occupancy or Vacancy.

- E. Lighting Control System Programming Protocol: Manufacturer's protocol.
- F. Lighting Control System (Room-Based Controller):
 - 1. Lighting Control System Room-Based Controller: Provide with data network to all lighting control system components, devices, and accessories. Provide network interface with other systems via BACnet IP communication or alternative protocol acceptable to the other system. System communication protocol shall be compatible with the building automation system.
- G. Time Clock and Scheduling: Provide 24 astronomical hour-based scheduling for interior lighting controls.
- H. Room-Based System Controllers (Room Controllers): Distributed room-based controller, integral switching relays and dimmers.
 - 1. Installation: Provide a dedicated controller for each space; not shared with adjacent rooms. Locate the controller near the associated wall controller, near the entry door when applicable, and above the finished accessible ceiling. As an alternative, the controller may be mounted above the finished accessible ceiling of the adjacent space when the associated ceiling space is not accessible. Example, located in adjacent corridor.
- I. Programming and Commissioning Dongle (Removable Style): Provide and permanently install a programming dongle for each room controller when a field removable dongle type device is required for programming and commissioning of the system. The programming dongle shall be permanently installed to allow for ease of programming the controller without above ceiling access.
- J. Control Devices: All automatic sensors (ultrasonic, PIR, dual technology, daylighting, photocell, timers), control stations, and other system components shall be provided with the system and designed to operate on system network. Sensors shall be powered from power supplies, modules, packs, or Power Over Ethernet POE. Refer to Standalone Line and Low Voltage Lighting Controls section of this specification for sensor performance descriptions (not duplicated in this section).
- K. Power Supplies (Modules, Packs, etc.): Provide power supplies for control devices. Power supply shall provide physical separation of 120/277 volt line voltage wiring and low voltage control wiring. Provide supplementary power supplies when required for multiple control devices. Provide switch or dimmed control as required by the Sequence Of Operation SOO.
 - 1. Installation: Install adjacent to wall room controller when applicable, near the entry door when applicable, and above the finished accessible ceiling. As an alternative, the controller may be mounted above the finished accessible ceiling of the adjacent space when the associated ceiling space is not accessible. Provide low voltage wiring to applicable control devices and control stations.

- L. Device Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20A, 125-volt AC for tungsten filaments and 20 A, 277-volt AC for electronic ballasts, minimum 50,000 cycles at rated capacity. Provide supplemental relays when required. (Example, occupancy sensor control of receptacle outlets or VAV/TAB HVAC units located in the same space.)
1. Building Automation Interface: Provide auxiliary relay to report occupancy status of each individual space to the building automation system. Refer to the drawings and sequence of operation schedule for requirements.
- M. SW-#B; Lighting Control Station, Default Dimming Control Raise/Lower/Fade: The lighting control station shall comply with the performance requirements of the lighting sequence of operation. The control station may consist of switches, pushbuttons, sliders, dimming functions, etc. Provide a common coverplate for lighting control stations.
1. #B: The '#' indicates the minimum quantity of unique lighting control scenes when shown plus raise/lower and lights 'off' scene. Refer to the Lighting Sequence Of Operation (SOO) for the minimum quantity of scenes required (when a number is not designated) and a description of each control scene.
 2. Subscripts:
 - a. (BLANK) = Dimming Control (Default)
 - b. S = Switch Control
 - c. W = Wireless w/ battery
 - d. # = Unique ID when applicable
 3. Manufacturer: Room-Based Lighting Controller Manufacturer:
 - a. Dimming (Blank) or Switch (S) Control Station: Modular, momentary pushbutton, with addressable capabilities to control the scene or luminaires assigned to the switch. The switch shall be able to actuate the functions based on the described sequence of operation and intended functions.
 - 1) Preset/fader stations shall operate using programmable buttons and/or faders as indicated on drawings.
 - 2) Raise, Lower, Integral Fader Control: Provide control station with manual raise and lower fader control for each control zone of lighting control. Manual raise/lower shall be separate buttons from scene control; hold and dim scene control buttons not acceptable. Faders may be physical sliders or up/down buttons. Fader range shall provide continuous even dimming matching full range of dimmer specification.
 - 3) Integral Pilot Light or LED: Indicate that controls are active or powered by being on continuously when powered or when pushbuttons are actuated.
 - 4) Labeling of buttons and faders shall be engraved/screened by manufacturer, using approved text returned with shop drawing submittals.

- 5) Station control components shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via direct or network connection. Function options include: preset selection, manual mode, record mode, station lockout, raise/lower, macro, cue, and room join/separate.
- 6) Multiple stations (shown in same space): When multiple control stations are shown in the same space the sequence of operation shall be the same at all locations unless noted otherwise.
- 7) Multiple stations (movable partitions in same space): When multiple control stations are shown in the same space with movable partitions the sequence of operations shall be the same at all locations unless noted otherwise. A wall partition switch shall monitor the status of the movable partitions and automatically associated the control station(s) with the appropriate space based on the status of the wall partition.

N. Global Operational Sequences:

1. Fire Alarm and Automatic Detection Sequence: A fire alarm system 'alarm' shall initiate an override of the local lighting control. The lighting in the following spaces shall be overridden to 100 percent "on" in the following areas: Corridors, hallways, stairways, spaces equipped with exit signs, main entrance, other egress paths, and occupancy spaces of Assembly. Provide provisions to add additional spaces to this applicable list as directed by the Authority Having Jurisdiction AHJ or Engineer.

2.6 AUTOMATIC LOAD CONTROL RELAY (ALCR)

- A. ALCR20; Automatic Load Control Relay ALCR, 120/277 volt, dry/damp listed, 32F to 113F (0C to 45C) operating temperature, plenum NEMA 1 rated, test button with visual indicator, remote test and fire alarm control, UL924 listed latest edition, Electrical Code Article 700 compliant.

1. Rating:
 - a. 20 amp (16 A permitted) LED driver and ballast.
 - b. 10 A (1,200 watt) incandescent.
2. Lighting Control Coordination: Provide ALCR device compatible with designated lighting zone controls. Example: switched, 0-10 volt dimming, DALI control, 2 wire dimming, or DMX.
3. Operation:
 - a. ALCR device shall allow the same local lighting control devices to control both the normal lights and emergency designated lighting. Devices that require separate local lighting controls for the normal and designated emergency lighting are NOT allowed.
 - b. ALCR device shall monitor the normal power circuit and shunt/bypass the local lighting controls upon loss of power, remote test switch, or fire alarm override to provide full lumen output for designated emergency lighting.

- c. ALCR device shall return designated emergency lighting to local lighting control after a 15-minute delay upon return of normal power or remote test/fire alarm override release.
- d. Equivalent Facilitation and Performance: A limitation of equivalent comparable products may require some of the required functions of the ALCR device to be provided by an alternative component of the lighting control system. The following functions may be performed by alternative components of the lighting control system when the device is listed for the required function and compatible with the lighting control system:
 - 1) Remote test switch / fire alarm override interface.
 - 2) The 15-minute time delay upon return of normal power or remote test/fire alarm override release.
- e. Accessory - Remote Test Switch: Provide a remote button test switch. The test switch shall be a single gang type switch compatible with the ALCR device and allow the remote fire alarm override to function.
 - 1) Test Switch Mounting:
 - a) Finished Spaces (ceiling height 10 feet or less): Flush mount device in finished ceiling adjacent to one of the emergency lights.
 - b) Finished Spaces (ceiling height greater than 10 feet): Flush mounted in wall. Refer to Architect/Engineer for location.
 - c) Unfinished Spaces: Adjacent and aligned with local wall-mounted lighting controls.
 - d) Option: ALCR device(s) with a test button, visual indicator, and flush mounting plate may be installed in the location of the remote test switch in lieu of providing a separate remote test switch.

4. Manufacturers:

- a. LVS Controls EPC-2 (switched)
- b. LVS Controls EPC-2-D Series (0-10V dimming)
- c. LVS Controls EPC-DMX (DMX) EPC Series (alternative lighting control)
- d. Iota ETS-20 (switched)
- e. Iota ETC-20-DR (0-10V dimming)
- f. Iota ETC Series (alternative lighting control)
- g. Myers Emergency Power Systems RLY-SW-2 (switched)
- h. Myers Emergency Power Systems RLY-DIM-2D (0-10V dimming)
- i. Myers Emergency Power Systems RLY Series (alternative lighting control)
- j. Nine24 Inc ELCR-R (switched)
- k. Nine24 ELCR-Z10 (0-10V dimming)
- l. Nine24 ELCR Series (alternative lighting control)
- m. Lighting control manufacturer

PART 3 - EXECUTION

3.1 PRE-CONSTRUCTION MEETING

- A. Schedule a pre-construction meeting with the controls representative, installing contractor, Architect/Engineer, and Owner to explain the proposed lighting control system and integration with other systems as when applicable per the design documents.

3.2 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts existing conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings.
- B. All wiring shall be installed in conduit.
- C. Low Voltage Cabling (less than 100 volts): Low voltage lighting control cabling shall be plenum listed. Low voltage cables in non-accessible areas shall be installed in conduit. Low voltage lighting control cable may be installed without conduit in accessible areas using the following types of cable supports. Cable support types/systems shall comply with the warranty requirements of the low voltage cable manufacturer.
 - 1. J-hooks; batwing type.
 - 2. Bridle rings with saddle supports.
 - 3. Low voltage cable batwings supported by independent luminaire support systems (luminaire support cabling); use of batwings on ceiling support systems not allowed.
 - 4. Listed cable ties. Low voltage cabling secured to exterior of luminaire power raceway.
- D. All branch load circuits shall be live tested before connecting the loads to the lighting control panel.
- E. Lighting Control Station Wiring: Provide the grounded (neutral) conductor portion of the branch circuit with the line voltage phase conductors at each lighting control station.
- F. Lighting Control Panel Directories: Provide a typewritten directory for each lighting control panel indicating relay/dimmer and description of load controlled.

3.4 INTEGRATION WITH OTHER SYSTEMS

- A. The Room-Based lighting control system interacts, is controlled by, or controls the following other systems per the design documents and lighting sequence of operations descriptions. The contractor shall provide the necessary communication gateways, relays, cabling, and programming to interact with the following systems.
 - 1. Building Automation System
 - 2. Fire Alarm and Automatic Detection System
 - 3. Security and Intrusion Detection System
 - 4. Audio/Visual Systems

3.5 BRANCH CIRCUIT POWER WIRING FOR CONTROLLERS

- A. Branch circuit power for the following lighting control system components shall be provided from the following branches. Lighting control power shall originate from the same branch circuits serving the controlled luminaires:
 - 1. Lighting Control System (Physical Server, Central Station, or Cloud-based Access): Life Safety Branch (Electrical Code Article 517)
 - 2. Room controllers, lighting control power supplies, devices, components, and accessories when an associated (ALCR) device is applicable to the lighting control sequence of operation: Life Safety Branch (Electrical Code Article 517)
 - 3. Room controllers, lighting control power supplies, devices, components, and accessories when an associated (BCELTS) device is applicable to the lighting control sequence of operation: The load side of the BCELTS device normal and emergency/life safety pending the status of the BCELTS.
 - 4. The contractor shall coordinate the branch circuit power source required with the Engineer when required for unique lighting control system devices, components, and accessories.

3.6 LOW VOLTAGE LIGHTING CONTROL CABLING

- A. Control Cable Raceway Routing: All wiring shall be installed in conduit.
- B. Control Cabling Installed with Line Voltage Wiring: When low voltage control cabling is installed with line-voltage wiring, the control wiring shall be, copper conductors, minimum 16 AWG or per manufacturer, with cable insulation equal to the line-voltage rating (voltage, temp rating, etc.) and comply with Specification Section 260513 "Wire and Cable."
- C. Network Cabling: As required by manufacturer.
- D. Splices and Taps: Tapping or wire trap connectors shall be used to splice all Class 1 and Class 2 control wiring. Twist-on, wire-nut type connectors are not allowed.

3.7 AUTOMATIC LOAD CONTROL RELAYS (ALCR20, ALCR3) AND BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH (BCELTS)

- A. Field install per manufacturer requirements.

- B. Remote Test Switch: Provide connection to remote test switch.
- C. Fire Alarm Override: Provide connection to addressable fire alarm relay.

3.8 SUPPORT SERVICES

A. System Startup:

1. Manufacturer shall provide factory authorized technician to confirm proper installation and operation of all system components.

B. Pre-Program, Testing, Training Coordination:

1. The construction documents and sequence of operations define the original design intent of the lighting controls as coordinated between the owner and the design team. The definition of the scope is intended to identify the hardware and programming flexibility required prior to programming, system testing, and owner training.
2. The final system programming, control station labels, scene presets, dimmer presets, dimmer range limits, fade times, etc. are subject to on site coordination between the design team, owner, contractor, and manufacturer. Contractor/manufacturer programming of the system prior to an onsite coordination with the owner and design team shall not be considered final programming nor commissioning.
3. The contractor and manufacturer shall provide on site representatives to provide final programming including preset, scene, switch labeling, and other programming adjustments based on owner and design team onsite observation and verbally requested adjustments as part of the based bid scope of work.
4. The contractor shall document onsite requested changes and update operation and maintenance manuals to match final programming.

C. Testing:

1. System shall be completely functional tested by a factory-authorized technician. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.
2. Programming of initial zones, schedules, lighting levels, control station groups, and sensor settings shall be performed by a factory-authorized technician. Lighting Control Sequence of Operation shall serve as a basis for programming, However, all final decisions regarding groups and schedules shall be at the direction of the Owner. The following procedures shall be performed at a minimum:
 - a. Confirm automatic sensor placement, sensitivity, and time delay settings to meet specified performance criteria.
 - b. Confirm daylight sensor placement, sensitivity, deadband, and delay settings to meet specified performance criteria.
 - c. Confirm that schedules and time controls are configured to meet specified performance criteria and Owner's operating requirements.
 - d. Confirm control station labeling, presets, switch labels, and scenes.

3. Verify occupancy/vacancy and daylight sensor operation is correct after furniture and equipment is installed in each area. Make adjustments to sensor settings and time delays to allow proper operation.
4. Verify occupancy/vacancy sensors are located to provide complete coverage for the area served with no nuisance switching.
 - a. Relocate sensors or provide additional sensors as necessary to provide adequate coverage.
 - b. Mask occupancy/vacancy sensors where necessary to prevent nuisance switching from adjacent areas.

D. Training:

1. Manufacturer shall provide competent factory-authorized technician to train Owner personnel in the operation, maintenance and programming of the lighting control system. Submit training plan with notification seven (7) days prior to proposed training dates.
2. Training duration shall be no less than three (3) days, with one (1) day being scheduled at least two (2) weeks after initial training.

E. Documentation:

1. Manufacturer shall provide system documentation including:
 - a. System one-line showing all panels, number and type of control stations and sensors, communication line, and network or building automation system BAS interface unit.
 - b. Drawings for each panel showing hardware configuration and numbering.
 - c. Panel wiring schedules.
 - d. Typical diagrams for each component.

3.9 SYSTEM COMMISSIONING

- A. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 010900, General Commissioning, for further details.
- B. Mask sensors where necessary to prevent nuisance switching from adjacent areas.
- C. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 010900, General Commissioning, for system verification tests and commissioning requirements.
- D. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 010900, General Commissioning, for Contractor training requirements.

END OF SECTION

SECTION 262419 - MOTOR CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual motor starters and switches

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule, Electrical Riser Diagram, and Equipment Connection Schedule for rating and configuration.

1.3 REFERENCES

- A. ANSI/UL Standard 508. Standard for Industrial Control Equipment
- B. FCC Rules and Regulations, Part 15, Subpart J- Radio Frequency Interference
- C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service
- D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)
- E. FS W-P-115 - Power Distribution Panel
- F. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted
- G. IEEE Standard 519-1981 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters
- H. NEMA AB 1 - Molded Case Circuit Breakers
- I. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies
- J. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- K. NEMA KS 1 - Enclosed Switches
- L. NEMA PB 1 - Panelboards
- M. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or less

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 260500.

- B. Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; wiring diagrams that differentiate between manufacturer-installed and field-installed wiring; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.
- C. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and over-current protective devices.
- D. Submit manufacturer's instructions under provisions of Section 260500.

1.5 SPARE PARTS

- A. Keys: Furnish four (4) each to the Owner.
- B. Fuses: Furnish three (3) spare fuses of each type and rating installed to the Owner.
- C. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 260500.
- B. Deliver in 60-inch maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.
- C. Store and protect products under provisions of Section 260500.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from fumes, dirt, water, construction debris, traffic, and physical damage.
- E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 260500.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

PART 2 - PRODUCTS

2.1 MANUAL MOTOR STARTERS MS-# AND SWITCHES MX-#

- A. Acceptable Manufacturers:
 - 1. Square D 2500 Series

2. Eaton MS Series
 3. ABB
 4. Siemens SMF / MMS Series
- B. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay, and toggle operator.
- C. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, and toggle operator.
- D. Enclosure: NEMA ICS 6; Type 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions on concrete bases.
- B. Select and install heater elements in motor starters to match installed motor characteristics.
- C. Set field-adjustable switches and circuit-breaker trip ranges.
- D. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

END OF SECTION

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Device plates and box covers
- B. Receptacles (REC-#)

1.2 RELATED SECTIONS

- A. Section 260538 - Underfloor Ducts.
- B. Section 260933 - Lighting Control Systems.

1.3 QUALITY ASSURANCE

- A. Provide similar devices from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Electrical Code, by a testing agency to Authorities Having Jurisdiction and marked for intended use.
- C. Comply with the Electrical Code.

1.4 REFERENCES

- A. DSCC W-C-896F - General Specification for Electrical Power Connector
- B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet
- C. NEMA WD 1 - General Color Requirements for Wiring Devices
- D. NEMA WD 6 - Wiring Devices - Dimensional Requirements
- E. NFPA 70 - National Electrical Code (NEC)
- F. UL 498 - Standard for Attachment Plugs and Receptacles
- G. UL 943 - Standard for Ground Fault Circuit Interrupters

1.5 SUBMITTALS

- A. Submit product data under provisions of Section 260500.
- B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

- C. Provide a non-returnable sample of each countertop and furniture-mounted receptacle assembly as part of the submittal process.

1.6 COORDINATION

- A. Receptacles for Owner Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 DEVICE COLOR

- A. All switch, receptacle, and outlet colors shall be verified with Architect, unless indicated otherwise.

2.2 COVERPLATES

- A. All switches, receptacles, and outlets shall be complete with the following:
 - 1. Unbreakable thermoplastic/thermoset plastic and match device color coverplates in finished spaces where walls are finished.
 - 2. #302 stainless steel coverplates in unfinished spaces for flush boxes.
 - 3. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.
- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 260553.
- D. Plate securing screws shall be metal with head color matching the wall plate finish.
- E. Hospital Grade: Coverplate touch surfaces shall have an antimicrobial additive that suppresses the growth of harmful bacteria, mold, mildew, and fungi. Cover plate color shall match the device color.
 - 1. Manufacturers:
 - a. Cooper CuVerro
 - b. Leviton 84 series
 - 2. Install antimicrobial cover plates in following departments:
 - a. Pharmacy, USP rooms, Lab
- F. Where indicated on drawings, provide compatible wire guards for devices to protect against damage and vandalism. Wire guards shall be constructed of durable coated steel wire.

2.3 RECEPTACLES

- A. Refer to Electrical Symbols List for device type.

- B. Devices that are shaded on the drawings shall be red.
- C. REC-DUP: NEMA 5-20R Duplex Receptacle:
 - 1. Spec Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and brass back strap.
 - a. Manufacturers:
 - 1) Hubbell 5352
 - 2) Leviton 5362-S
 - 3) Pass & Seymour 5362
 - 4) Cooper 5362
 - 2. Hospital Grade: 125-volt, 20 amp, 3-wire grounding type hospital grade with impact resistant thermoplastic face and one-piece nickel-plated brass back strap with integral ground contacts.
 - a. Manufacturers:
 - 1) Hubbell HBL8300
 - 2) Leviton 8300
 - 3) Pass & Seymour 8300
 - 4) Cooper AH8300
- D. REC-DUP-GFI: NEMA 5-20R Ground Fault Duplex Receptacle:
 - 1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face, listed.
 - a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
 - b. Manufacturers:
 - 1) Hubbell GF20L
 - 2) Leviton GFNT2
 - 3) Pass & Seymour 2097
 - 4) Cooper SGF20
 - 2. Hospital Grade: 125-volt, 20 amp, 3-wire grounding type hospital grade with test and reset buttons in impact resistant thermoplastic face, listed.
 - a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
 - b. Manufacturers:
 - 1) Hubbell GFRST83
 - 2) Leviton GFNT2-HG
 - 3) Pass & Seymour 2097HG
 - 4) Cooper SGFH20
- E. REC-SIM-L630R: NEMA L6-30R Locking Type Simplex Receptacle:
 - 1. 250-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.

- a. Manufacturers:
 - 1) Hubbell HBL2620
 - 2) Leviton 2620
 - 3) Pass & Seymour L630R
 - 4) Cooper CWL630R
- F. REC-QUAD: NEMA 5-20R Double Duplex Receptacle:
 - 1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.
 - a. Manufacturers:
 - 1) Refer to Duplex Receptacle above.
- G. REC-QUAD-GFI: NEMA 5-20R Double Duplex GFI Receptacle:
 - 1. Consists of two duplex GFI receptacles, double gang box, plaster ring and faceplate.
 - a. Manufacturers:
 - 1) Refer to Duplex GFI Receptacle above.
- H. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.
- I. Side wired devices shall have four binding screws that are undercut for positive wire retention.
- J. Ground fault circuit interrupter (GFCI) receptacles shall be listed and comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.
- B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.
- C. Ground Fault Protection: Provide ground fault protection for all branch circuit breakers serving 120/208 receptacles and electrical outlets rated 50 amps or less single-phase and 100 amps or less three-phase in the following locations, as shown on drawings, or required by adopted code:

1. Bathrooms, locker rooms, shower rooms
 2. Kitchens' all 120-volt through 250-volt receptacles
 3. Buffet, serving, food preparation areas; all 120-volt through 250-volt receptacles
 4. Rooftops
 5. Interior/Exterior locations subject to damp/wet conditions
 6. When located within 6 feet of sinks, bathtubs, and shower stalls
 7. Plug-and-cord receptacles when the utilization appliance is located within 6 feet of a sink edge.
 8. Aquariums and bait wells
 9. Garages, accessory buildings, service bays
 10. Accessory dwelling buildings
 11. Exterior dwelling outlets (disconnects, equipment connections, etc.) when required by code.
 12. Boathouses
 13. Specific Appliances: Auto vacuum machines, water drink/bottle fill coolers, pressure staying machines, tire inflation machines, vending machines, sump pumps, dishwashers, electric ranges, ovens, clothes dryers, microwave ovens
 14. Horticultural luminaire branch circuits
 15. Future Provisions: Provide a conduit raceway and backbox for the future addition of countertop pop-receptacle when receptacles are not installed in kitchen islands and peninsulas.
- D. Arc-Fault Protection: Provide arc-fault protection for all branch circuit breakers serving the following spaces, or required by adopted code.
1. Dwelling unit living and occupied areas including but not limited to kitchens, family, dining, living, parlors, libraries, dens, bedrooms, sunrooms, recreation, closets, hallways, laundry, and similar spaces.
 2. Dormitory bedrooms, living rooms, hallways, closets, bathrooms, and similar rooms
 3. Guest rooms and guest suites
 4. Sleeping rooms for nursing homes, limited care, and similar non-dwelling living quarters dedicated to sleeping
- E. Tamper Resistant Protection: Provide tamper resistant protection for all 15 / 20-amp 120/208 straight blade wiring devices in the following locations, as shown on the drawings, or required by adopted code.
1. Dwelling units and accessory dwelling unit structures
 2. Boathouses
 3. Dormitory units
 4. Guest rooms, guest suites, and common public areas
 5. Childcare, preschool, elementary, middle, high school, educational facilities
 6. Medical Business Office: Offices, corridors, waiting rooms, common areas
 7. Public Buildings: Corridors, waiting rooms, common areas
 8. Public Spaces involving: Transportation waiting, gymnasiums, fitness centers, auditoriums, public use venue common areas
 9. Nursing homes, assisted living, psychiatric spaces, substance abuse, foster care facilities
 10. Agricultural buildings common areas accessible to the public

- F. Drill opening for poke-through fitting installation in accordance with manufacturer's instructions. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This may include X-ray or similar non-destructive means.
- G. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.
- H. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.
- I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.
- J. Install devices and wall plates flush and level.
- K. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 260553 - Electrical Identification.
- L. Test receptacles for proper polarity, ground continuity and compliance with requirements.
- M. Healthcare devices shall be tested in accordance with NFPA 99 6.3.3 for grounding, voltage, and impedance measurements.
- N. Floor Box Installation:
 - 1. Set boxes level and flush with finish flooring material.
 - 2. Use cast iron floor boxes for installations in slab on grade. Trim shall match floor covering to be used.
 - 3. Provide a minimum horizontal offset of 24 inches between boxes.
 - 4. Provide saw-cutting and patching of existing concrete floors as necessary for floor box installations within existing floors.

END OF SECTION

SECTION 262816 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fusible switches
- B. Non-fusible switches
- C. Enclosures

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule for rating and configuration.

1.3 REFERENCES

- A. NEMA KS 1 - Enclosed Switches

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 260500.
- B. Product Data: For each type of enclosed switch, circuit breakers, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.
- C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.5 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE AND NON-FUSIBLE SWITCHES

- A. Acceptable Manufacturers:
 - 1. Square D 3110 Series
 - 2. Eaton DH Series
 - 3. ABB TH Series
 - 4. Siemens HNF / HF Series

- B. FDS-#; Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.
- C. DS-#; Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool. Handle lockable in OFF position.
- D. Enclosures: Type as indicated on the disconnect schedule.
- E. Accessories: Provide the following accessories. Refer to Disconnect Schedule for additional requirements for each application.
 - 1. Lockable
 - 2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches where indicated on the drawings.
- B. Install fuses in fusible disconnect switches.
- C. Field coordinate installation with other contractors and equipment to maintain code required working space requirements.
- D. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

3.2 ADJUSTING

- A. Set field-adjustable circuit breaker trip ranges.

END OF SECTION

SECTION 262923 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Variable frequency drives (VFD-#)

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Variable Frequency Drive Schedule for rating and configuration.
- B. Division(s) 21, 22, 23 - Fire Protection, Plumbing, and Mechanical when referenced.

1.3 REFERENCES

- A. ANSI/UL Standard 508
- B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- C. Standard for Harmonic Control in Electrical Power Systems IEEE 519-2022 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters
- D. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 260500.
- B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- C. Product Data: Provide catalog sheets showing PWM configuration (6, 12, 18 pulse, Active Front End AFE), voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- D. Product Data for Accessories and Options: Provide catalog sheets showing voltage, dimensions, ratings, for accessories and options. Include information for passive harmonic filters, active harmonic filters, line reactors, shielded VFD cabling, output filters, etc. as an inclusive submittal package provided by the VFD supplier. The VFD supplier shall act as a single contact of responsibility.
- E. Seismic Requirements: Provide data as defined in Section 260548 Seismic Requirements for Equipment and Supports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

- G. Contractor's Letter of Acknowledgement: The contractor shall include a letter acknowledging the following with date and signature. The letter shall include a location for the installing contractor to sign the document:

1. The manufacturer/vendor received a complete copy of the design document specifications, plans, and schedules as related to the variable frequency drive requirements for the project.
2. The contractor and manufacturer have reviewed the distance relationship between the VFD location and the motor(s) served in conjunction with the installing contractors cable routing plan. The submittal includes compliance with the minimum requirements for each specific application including the addition of harmonic filters and shielded VFD cabling. The contractor is responsible for compiling and documenting information including cable lengths for mutual review with the manufacturer.
3. Leading Power Factor Management: The manufacturer has reviewed the design and identified VFD applications scheduled to operate on a generator power source.

- H. VFD Harmonic Analysis:

1. Provide harmonic analysis of each individual variable frequency drive based on the latest IEEE 519 for voltage (THD) and current (TDD) distortion limits at the input terminals of the VFD.
2. Provide a summary of the individual harmonic analysis for each VFD in tabular form to document compliance with the minimum harmonic distortion criteria.
Example:

- a. VFD - TAG
- b. Current distortion (TDD): percent at terminals of VFD
- c. Input Line reactor, DC link choke, or LCL filter rating: percent
- d. Leading Power Factor Control management applied: Yes or No
- e. Filtering: List application specific options and accessories included for compliance with the contract documents and manufacturer recommendations including filters and shielded VFD cabling.

- I. IEEE 519 Harmonic Analysis Report: Provide harmonic distortion analysis of the total electrical distribution system. The report shall verify the proposed variable frequency drives proposed do not exceed the latest version of IEEE 519 for voltage (THD) and current (TDD) distortion limits at the PCC. The Point of Common Coupling (PCC) shall be defined as the secondary side of the consumer-utility interface or secondary side of the main service transformer of the facility for the purposes of this report.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 260500.
- B. Accept controllers on site in original packing. Inspect for damage.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 260500.
- B. Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.
- C. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- D. Shop Drawings: For each VFD.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. UL listing for series rating of overcurrent protective devices in combination controllers.
 - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.
- E. Manufacturer Seismic Qualification Certification: Submit certification that VFDs, accessories, and components will withstand seismic forces defined in Division 26 Section 260548 "Seismic Requirements for Equipment and Supports". Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Variable Torque Applications:

1. Toshiba Q9 Series
2. ABB ACH 580 (HVAC) / ACS 580 (other applications) Series
3. Allen Bradley PowerFlex Series
4. Danfoss VLTFC100 Series
5. Mitsubishi FR-F800 Series
6. Eaton MMX / HMX / SVX Series
7. Yaskawa HV600 Series

B. The Variable Frequency Drive Schedule and drawings use equipment tags to define the scope of the project. The equipment tag (example: VFD-5) may be representative of multiple similar applications. Additional options and accessories may be required by the specifications and manufacturer recommendations due to the specific application but not represented in the Variable Frequency Drive Schedule. Refer to the Options, Accessories, and minimum performance requirements of this specification for a complete list of requirements (example: output filters and shielded VFD cables).

C. Motor Nameplate (Drive Output) Voltage: Refer to Variable Frequency Drive Schedule and Mechanical Schedules when applicable.

2.2 MINIMUM PERFORMANCE, REQUIRED OPTIONS, AND ACCESSORIES

A. The following minimum performance requirements, options, and accessories supplement the requirements of the Variable Frequency Drive Schedule. In the event of a conflict between the schedule and specification the most stringent requirement will be enforced.

1. Manual Speed Adjustment
2. Electronic Thermal or bi-metal Overloads
3. Control Transformer, Fused, 120 volt. Acceptable Alternative, 120 volt / 24 volt power supply available directly from VFD, 100mA minimum.
4. Hand-off-Auto Door Switch
5. Skip Frequency Capability

B. Line Input Reactor: Provide all VFDs with a minimum input line reactor of (3%). The input line reactor may be integral or individually mounted.

1. Exception: The manufacturer may substitute an LCL type harmonic filter with an input harmonic filter; an approximate equivalent (3%) impedance from the harmonic filter is anticipated.
2. Exception: A dual (positive and negative) 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter. Exception: Not required for Active Front End AFE drives with an IGBT front end instead of a diode-bridge configuration.

- C. Forced Ventilation Accessories and Operation: Provide per manufacturer requirements as required for the standard performance of the drive, the application, and environmental conditions.
1. Provide inlet air outlet filter when a fan is provided. Provide an outlet filter if appropriate for the physical construction of the VFD.
 2. Field replaceable blower fan sized to maintain VFD at rated operating temperatures for ambient conditions of enclosure location. The VFD manufacturer's air change requirements shall be satisfied or exceeded for enclosed applications.
- D. Harmonic Distortion Performance Criteria (PCC defined at VFD): The variable frequency drive shall have the following minimum harmonic distortion performance criteria; reference to the latest edition of IEEE 519. The Point of Common Coupling PCC shall be considered the input line terminals of the combination VFD, applicable filters, and accessories for the following requirements.
1. Design Commentary for the benefit of the contractor, vendor, and manufacturer. The IEEE 519 Standard defines harmonic distortion performance based on a "good neighbor" criteria and overlooks good design practice criteria within the end-user's facility. The Harmonic Distortion Performance Criteria associated with this specification exceeds the minimum industry recognized performance criteria by defining the performance at the VFD. The specification defines a combination of acceptable VFD, passive/active filters, and other accessories. The intent is to promote competition while allowing each manufacturer to offer their best value based solution(s) for the benefit of the project. An industry recognized IEEE 519 Harmonic Analysis Report has been listed as a submittal requirement when required for compliance and documentation purposes when required.
 2. The minimum configuration represents the minimum acceptable solution to achieve THDv and TDDi performance requirements. Alternative approved solutions have been listed and shall be substituted within the scope of the original bid pricing when the minimum configuration does not satisfy the harmonic performance requirements listed.
 3. Equivalent HP rating: When a single VFD is configured to serve multiple smaller motors (example: skid packaged equipment, fan wall systems) the equivalent sum of the motor HPs (VFD HP rating) shall be considered the HP rating for the following criteria.
 4. VFD rating 15 HP or less:
 - a. Minimum Configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
 - 1) Voltage Total Harmonic Distortion (THDv) limit: 8 percent
 - 2) Current Total Demand Distortion (TDDi) limit: 8 percent
 - b. Approved Solutions for Minimum THDv and TDDi Performance: The following approved solutions or a combination of the following is acceptable:

- 1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.
 - 2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.
 - 3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.
 5. VFD rating exceeding 15HP to 99HP:
 - a. Minimum configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
 - b. Minimum Performance Criteria:
 - 1) Voltage Total Harmonic Distortion (THDv) limit: 8 percent
 - 2) Current Total Demand Distortion (TDDi) limit: 8 percent
 - c. Approved solutions for minimum THDv and TDDi performance: The following approved solutions or a combination of the following is acceptable:
 - 1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.
 - 2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.
 - 3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.
- E. VFD Output Load Terminals - Minimum Design Requirements:
1. Provide external output line reactors, DV/DT, sine filters, and shielded VFD cable when the manufacturer's recommended maximum distance between the VFD and the motor(s) is exceeded.
 2. Provide the following minimum design criteria in addition to manufacturer recommendations:
 - a. Output line reactor (3 percent): When recommended by manufacturer.
 - b. DV/DT output line reactor: VFD to motor distance exceeds 75 feet (480 volt) or 150 feet (240/208 volt).
 - c. Sine Wave Output Line Reactor: VFD to motor distance exceeds 150 feet (480 Volt) or 280 feet (240/208 Volt).
 - d. Shielded VFD Motor Cable: Horsepower ratings exceeds 100 HP for any cable length.

- F. Leading Power Factor Management: The project includes a packaged engine emergency generator. VFD applications including a capacitor solution (example: Harmonic Filters) shall include provisions to disconnect or step control the capacitor components when the associated motor load is not operating to prevent a leading power factor while operating on the generator power source.

2.3 VFD DESCRIPTION, RATINGS, DESIGN

- A. Pulse Width Modulated (PWM) Variable Frequency Drives:
1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC motors. The controller shall be suitable for use with standard inverter duty motors without requiring any modifications to the motor or the drive.
 2. Drives shall be capable of use with commercially available Internal Permanent Magnet (IPM) motors up to 12 poles.
 3. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz.
 - a. 50HP applications and less: If derating of the inverter is necessary to run at 8kHz, then the unit's derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.
- B. Short Circuit Current Rating SCCR Default: 100 KA. Provide integral circuit breaker or fuse switch with disconnect switch when required to achieve rating.
- C. Drive and controller shall be capable of continuous full load operations throughout the following specified environmental operating conditions. Drive shall be capable of operation in the 'forward' and 'reverse' direction.
1. Operating Ambient Temperature: 0°C to 40°C.
 2. Minimum Relative Humidity Range: 5% to 90% (non-condensing).
 3. Minimum Elevation without Derating: 3300 feet.
 4. The VFD shall incorporate a protective coating on the main control board to conform to IEC60721-3-3 class 3C2 levels.
- D. Input Voltage Performance: The drive shall provide full rated output from a line voltage range of -15 / +10% nominal voltage.
- E. Controller shall have the functional components listed below:
1. Door interlocked input circuit breaker/fused switch.
 2. Input rectifier section to supply fixed DC bus voltage.
 3. Smoothing reactor or choke for DC bus.
 4. DC bus capacitors.
 5. Control transformer or switch mode powered from all three phases.
 6. Separate terminal blocks for power and control wiring.
 7. Terminal block for operator controls.
 8. Sine weighted PWM generating inverter section.

F. Enclosure Fabrication:

1. Enclosure: NEMA 250, Type 1, unless otherwise specified.
2. Finish: Manufacturer's standard enamel.
3. Devices shall be factory installed in controller enclosure and functionally tested unless otherwise indicated.

G. Displays: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current). Include meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

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. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

H. Status Indication Door-mounted display shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

I. 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.

J. Panel-Mounted Operator Station or KeyPad, Start-stop, auto-manual selector switches with manual speed control potentiometer, and elapsed time meter: NEMA ICS 2, heavy-duty type.

K. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

L. Control Relays: Auxiliary and adjustable time-delay relays.

M. Protection:

1. Input transient protection by means of surge suppressors or equivalent protection.
2. Snubber networks to protect against malfunctions due to system transients.
3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
4. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.
5. Motor thermal overload relay(s) adjustable and capable of NEMA Class 20 motor protection and sized per motor nameplate data. When multiple motors are connected to the VFD output, each motor shall have a manual starter with properly sized overload protection.
6. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination. Skip frequency feature is acceptable.
7. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection (fuses or circuit breaker).
11. Motor overtemperature fault.
12. Loss of load protection.

N. For a fault condition other than an internal fault, an auto restart function shall provide up to 10 programmable restart attempts. The programmable time delay before each restart shall range from 0 to 10 seconds.

O. The deceleration ramp of the controller shall be programmable for normal and fault conditions. Stop modes shall include: DC injection braking, controlled deceleration to stop and coast to stop.

P. Upon loss of the analog speed reference signal the following shall be selectable:

1. The VFD follows the programmed deceleration ramp to a controlled stop.
2. The VFD holds the speed based upon the last good value and trigger a warning alarm.

Q. The VFD operates at a pre-determined frequency (user programmable).

R. STOP key on the keypad shall be functional at all time, drive mode insensitive.

S. The VFD shall be insensitive to input power phase sequence. Input phase loss detection shall be available.

T. The output frequency shall be parameter setting enabled to fold back when the motor is overloaded (stall prevention).

U. For pump applications, the VFD shall incorporate a forward/reverse pump start sub-routine to assist with clogging.

- V. An optional real time clock feature shall be available, which must facilitate the time stamping of any drive trip messages.
- W. The VFD shall monitor the main circuit capacitors, control circuit capacitor, in-rush suppression circuit, and cooling fan and shall provide a pre-alarm so that maintenance can be scheduled.
- X. The VFD shall include an output timer function so that peripheral equipment maintenance can be scheduled.
- Y. The VFD shall include parameter selectable input and output phase loss protection.
- Z. The VFD basic insulation level shall be tested based upon ANSI/IEEE C62.41-1999.
- AA. The VFD shall be rated as a safety VFD (STO) EN ISO 13849-1 PLd/Cat.3, EN61508, and EN61800-5-2 SIL 1 without additional options.
- BB. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
- CC. Minimum Efficiency at Full Load: 96 percent.
- DD. Overload Capability: 1.1 times the base load current for 60 seconds every 10 minutes; 1.3 times the base load current for 2 seconds every minute.
- EE. Starting Torque: 100 percent of rated torque or as indicated.
- FF. Speed Regulation: Plus or minus 1 percent with no motor derating.
- GG. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.
- HH. The drive shall provide self-protection when the load is lost or disconnected without damage to the drive.
- II. Acceleration Rate Adjustment: 0.5 - 30 seconds.
- JJ. Deceleration Rate Adjustment: 1 - 30 seconds.
- KK. Minimum Adjustment Range for the Output Frequency shall be: 0 to 90 Hertz.
- LL. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hertz.
- MM. Provide MANUAL-OFF-AUTOMATIC selector switch and manual analog speed control mounted on the front of the enclosure.
- NN. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.
- OO. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.

- PP. Provide adjustable skip frequencies on the drive output (minimum of three ranges).
- QQ. Automatic Reset/Restart: Attempts up to 10 restarts after controller fault, on return of power after an interruption, or on undervoltage fault, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load (coasting motor restart).
- RR. Excitation Control will regulate motor output voltage based on torque requirement. Must be able to provide full motor torque when necessary across the operating speed range.
- SS. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- TT. Control Transformer: Provide control power transformer for control, 120 volt secondary, fused.
- UU. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0 to 10-V dc.
 - b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Ethernet.
 - g. Keypad display for local hand operation.
 3. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
 5. The control power for the VFD digital inputs and outputs shall be 24Vdc, selectable to sink or source. Optional 120Vac control power for the digital inputs and outputs shall be available.
 6. The drive control board shall be capable of operating from an independent 24V dc power supply.
 7. All logic connections shall be furnished on a removable terminal strip.
 8. External devices shall be able to be connected to the terminal strip for starting/stopping the VFD, speed control and indicating operation status.
 9. Speed command input shall be by means of:
 - a. Keypad.
 - b. Analog input.
 - c. Serial communications.
 - d. Ethernet communications.
- VV. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 230900. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.
- WW. Control:
1. With the "Manual-Off-Auto" switch in the "Manual" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the manual speed potentiometer on the drive door or keypad.
 2. With the "Manual-Off-Auto" switch in the "Auto" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the input signal from an external source.
 3. If applicable, with the "Drive-Bypass" in the "Bypass" position, regardless the position of the "Manual-Off-Auto" switch, the motor shall be connected across the lines and shall be run at full speed.
 4. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.
 5. If applicable, signal from the fire alarm control panel shall shut down VFD and bypass to direct-on-line operation. In this mode the thermal overload relay for the motor must be disabled.
- XX. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.

- YY. Convertible Auxiliary Contacts (additional): Provide two additional convertible normally open / normally closed contacts.
- ZZ. Electronic Thermal Overloads: Provide adjustable electronic type thermal overloads. Size protection per motor nameplate data.
- AAA. Multiple Motor Thermal Overloads: Provide manual starter disconnect switch with electronic thermal overloads for each individual motor when the VFD is scheduled to server multiple motors. Size protection per motor nameplate data.

2.4 OPTIONS AND ACCESSORIES - DESCRIPTIONS

- A. Passive Harmonic Filter: LCL (input line reactor, capacitor, tuned inductor) type sized by manufacturer for application. Provide leading power factor management for when the motor/VFD are not operating.
 - 1. When required:
 - a. As required to satisfy, the Harmonic Distortion Performance Criteria described in Part 2 of this specification.
 - b. Per VFD schedule.
- B. Active Harmonic Filter: LCL (input line reactor, capacitor, tuned inductor) type sized by manufacturer for application. Provide leading power factor management for when the motor/VFD are not operating. Provide all VFDs coupled with an Active Harmonic Filter with a minimum three percent (3%) input line reactor; or larger per manufacturer requirements.
 - 1. When required:
 - a. As required to satisfy, Harmonic Distortion Performance Criteria described in Part 2 of this specification.
 - b. Per VFD schedule.
- C. Active Bridge Rectifier Stage: Capable of limiting current harmonic distortion at the drive input terminals.
 - 1. When required:
 - a. As required to satisfy, Harmonic Distortion Performance Criteria described in Part 2 of this specification.
 - b. Per VFD schedule.
- D. Dynamic Braking: The VFD shall incorporate terminals for adding an external braking unit to allow for dissipation of excessive electrical energy from the motor. Provide dynamic braking with load resistor or DC injection braking to provide a means of rapid deceleration of the AC motor within one (1) minute. Adjust the controls to stop the motor within 30 seconds.

1. When required:
 - a. 100HP or larger applications.
 - b. VFD served by package engine generator.
 - c. Per VFD schedule or other portions of this specification.
 - d. All VFDs supplied for fan applications when VFD is not capable of capturing a free spinning load without damage to the VFD or motor.
 2. All high inertia loads that cannot be stopped in 30 seconds with the VFD dynamic braking or DC injection braking shall be provided with a chopper module and dynamic braking resistor to stop the motor within 30 seconds. The following options shall be available:
 - a. Adjustable operation frequency, time, and voltage.
 - b. External line regeneration.
 - c. Shared DC bus capability systems for multiple drive regeneration.
- E. Three- Contactor Manual Bypass:
1. When required: Per VFD schedule.
 2. Provide contactors, motor running overload protection, under-voltage and loss of phase protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch or third contactor to allow maintenance of inverter during bypass operation.
 3. All bypass circuitry shall be located within the same enclosure as the variable frequency drive.
 4. All fire alarm and/or smoke control interconnections (e.g., air handling unit shutdown) shall apply regardless of whether control is through VFD or bypass.
 5. Provide a Drive-Bypass Selector Switch.
 6. When operating in bypass mode, the main power supply to the VFD shall be disconnected and isolated for service.
 7. Provide nameplate with instructions for switching from drive to bypass and from bypass to drive. Provide instructions for isolating VFD for maintenance.
- F. Shielded VFD Motor Cable:
1. When required:
 - a. Per VFD schedule.
 - b. Required by other portions of this specification.
 - c. Recommended by the manufacturer.
 2. Multi-conductor single overall jacket cable, AC motor application controlled by PWM pulse-width modulation VFD applications, minimum 2000 volt rated, copper phase conductor(s) to match motor application and ratings, three copper conductor ground in direct contact with shield, copper tape or braided shield, provide with wire termination kits at VFD and motor, install per manufacturer recommendations.
 3. Conduit Raceway: Contractor to size raceway per code and cable cross sectional area provided by manufacturer.

4. Installation: Contractor shall install without cable splices between VFD and motor unless approved by engineer prior to installation.
- G. Forced Cooling / Heating Cabinet Enclosure:
1. When required:
 - a. Per VFD schedule.
 - b. When VFD is located exterior to the building or specified with a NEMA 3R, 4, 4X, or 12 enclosure.
 2. Provide custom VFD enclosure with DX based cooling system, strip heaters, and thermostat temp controller.

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. Refer to startup and commissioning requirements.
- B. The VFD and all associated controller components shall be covered by a supplier parts warranty of 2 years from the time of installation. There shall be an option to extend the warranty to 5 years if initial installation is carried out by a supplier-approved contractor.

3.2 INSTALLATION

- A. Install variable frequency drive equipment in accordance with the manufacturer's instructions.
- B. Install harmonic filter components in accordance with manufacturer's instructions. Locate filters above or below VFD to minimize use of available horizontal wall space pending field conditions.
- C. Adjust VFD settings per recommendations of the harmonic filter manufacturer's instructions; example: switching frequency.
- D. VFD Output Feeder and Raceway: The contractor shall provide VFD shielded cable for the VFD output feeder when the distance to the motor exceeds manufacturer recommendations or the requirements of this specifications. Contractor to size raceway per code and cable cross sectional area provided by manufacturer.
- E. Floor mount VFD on prefabricated or field fabricated supports with controls no higher than 6'-6" and no lower than 3'-0" AFF. Mount supports on 1/2" thick vibration isolation pads set on concrete housekeeping pads.
- F. Provide engraved phenolic nameplates under the provisions of Section 260553.
- G. Connections: All conduit connections to the VFD shall be by flexible conduit.
- H. Input, output, and control wiring shall each be run in separate conduits.

- I. All interlocking required by the drive manufacturer shall be the responsibility of the Electrical Contractor.
- J. Forced Cooling / Heating Cabinet Enclosure: Coordinate installation with field conditions and manufacturer instructions. Provide additional branch circuit(s) for cooling and heating system per manufacturer requirements.

3.3 STARTUP AND COMMISSIONING

- A. The Electrical Contractor shall have a factory service engineer present for the start-up, field calibration, and check-out of each VFD installed. Factory service engineer shall be required to return to the site for recalibration or set-up should unit not function as specified during system commissioning. All costs shall be a part of This Contract. Provide tag with date and signature of factory service Engineer on inside cover of each drive.
- B. Verify all settings, parameters, and adjustments with other contractors prior to startup. Make all adjustments and setting to coordinate with controls and equipment.
- C. Accelerate the motor to full speed and verify operation. Decelerate the motor to a stop and verify operation. Slowly operate the motor over the speed range and check for resonance.
- D. Make all adjustments and settings to coordinate with controls and equipment prior to Substantial Completion. Verify that drive is set for auto restart after power loss and undervoltage fault.
- E. Document settings in the Operations and Maintenance manual.

END OF SECTION

SECTION 265119 - LED LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Interior luminaires and accessories
- B. Light-emitting diode (LED) luminaire systems
- C. LED emergency lighting units
- D. Emergency exit signs

1.2 RELATED SECTIONS

- A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:
 - 1. 26 09 34 Lighting Control Systems
 - 2. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

1.3 REFERENCES

- A. ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products
- B. ANSI C82.16 - Light-Emitting Diode Drivers - Method of Measurement
- C. ANSI C82.77 - Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment
- D. NFPA 70E - National Electrical Safety Code
- E. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays or System
- F. UL 8750 - Light Emitting Diode (LED) Equipment for use in Lighting Products
- G. LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
- H. LM-80 - Measuring Luminous Flux and Color Maintenance of LED

- I. FS W-L-305 - Light Set, General Illumination (Emergency or Auxiliary)
- J. UL 924 - Standard for Emergency Lighting and Power Equipment

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 260500.
- B. Basic Requirements of Submittal:
 - 1. Submit product data sheets for luminaires, LED light engines, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with luminaires listed in ascending order, and with each luminaire's, LED light engine, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.
 - 2. Submit lens product data, dimensions and weights if not included in product data sheet submittal.
 - 3. Include outline drawings, support points, weights, and accessory information for each luminaire.
 - 4. Submit manufacturer origin of LED chipset and driver.
- C. LED Lighting - Performance Testing Submittal (when requested by Architect/Engineer):
 - 1. IESNA LM-79: Include photometric report for the latest generation system being furnished. Provide name of independent testing laboratory, report number, date of test, luminaire series/model number, input wattage, and light source specifications.
 - 2. IESNA LM-80: Measuring Lumen Maintenance of LED Light Sources.
- D. LED Lighting - Control Compatibility Submittal:
 - 1. Submit lighting control capability data for each LED luminaire. The submittal shall clearly identify device data proposed by the Contractor and approved by the luminaire manufacturer for dimming, switching, addressable, wireless, and similar control characteristics.

1.5 EXTRA STOCK

- A. Provide extra stock under provisions of Section 260500.
- B. LED Light Engines or Modules: Three (3) percent of quantity installed, minimum one (1) of each size and type of field replaceable light engine or module. Provide field replacement installation instructions.
- C. Lenses: Three (3) percent of quantity installed, minimum one (1) of each size and type.
- D. LED Drivers: Three (3) percent of quantity installed, minimum one (1) of each size and type.

- E. Exit Signs: Provide Three (3) additional exit sign luminaires complete with labor, conduit, and wire. Additional exit luminaires shall be located per the Architect/Engineer or provided as attic stock when a location is not defined prior to Owner occupancy. When multiple exit signs are scheduled, the quantity listed above shall represent each type listed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site. Store and protect under provisions of Section 260500.
- B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.
- C. Handle site lighting poles carefully to prevent breakage and damage to finish.

1.7 WARRANTY

- A. The warranty period begins at the date of Substantial Completion.
- B. LED Light Engines and Drivers:
 - 1. LED Drivers and Dimming Drivers: Five (5) years
 - 2. Light Emitting Diode (LED) Light Engines: Five (5) years
- C. Emergency Lighting Units and Exit Signs:
 - 1. Emergency Lighting Units: Three (3) year, non-prorated
 - 2. Exit Signs: Three (3) year, non-prorated
 - 3. Emergency Unit and Exit Sign Battery: Sealed lead acid or lead calcium cell, requiring no maintenance or replacement for ten (10) years under normal conditions.
- D. Emergency Drivers:
 - 1. Emergency LED Driver: Three (3) years

1.8 REGULATORY REQUIREMENTS

- A. Conform to NFPA 101 for installation requirements.

PART 2 - PRODUCTS

2.1 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Lensed Troffers: Provide hinged frames with latches and 0.125-inch thick virgin acrylic lenses. Prismatic lenses shall have depth of no less than 0.080", KSH12 or equal. Other lenses as scheduled.

- B. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.
- C. Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction.
- D. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified. Verify suspension length prior to submittal.
- E. Painted reflector surfaces shall have a minimum reflectance of 90%.
- F. All painted components shall be painted after fabrication.
- G. Where indicated on drawings, provide wire guards for luminaires to protect against damage and vandalism. Wire guards shall be constructed of durable coated steel wire.

2.2 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

- A. Refer to the luminaire schedule for color temperature and minimum color rendering index CRI requirements. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.
- B. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.
- C. Rated life shall be minimum of 50,000 hours at L70.
- D. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.
- E. Luminaire delivered lumens is defined as the absolute lumens per the manufacturers LM-79-08 test report.
- F. LED luminaires shall be designed for ease of component replacement including modular replaceable boards or Zhaga sockets. Luminaires that are factory sealed and do not have field replaceable parts shall provide a 10-year warranty.
- G. LED light engine shall have a maximum LLD of 0.85 at 50,000 hours at 25°C ambient.
- H. LED Driver:
 - 1. Solid state driver with integral heat sink. Driver shall have over-heat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 10%. Driver shall have a voltage fluctuation tolerance of +/- 10%.
 - 2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type. Dimming shall control light output in a continuous curve from 100% to 10% unless noted otherwise.

3. Driver shall have a minimum of 50,000 hours rated life.
4. Driver shall be tested to ANSI C82-16 for input current inrush, total harmonic distortion (THD), and power factor. Driver start time shall be less than 0.5 seconds to 98% of initial light output. Flicker should be less than 30% throughout the operating range.
5. Driver shall be field replaceable without removal of the luminaire.
6. Class A sound rating; inaudible in a 27 dBA ambient.
7. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.

2.3 EMERGENCY EXIT SIGNS

- A. Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings.
- B. Directional Indicators: The directional indicator for exit signage shall be of a chevron type meeting all requirements of NFPA 101.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Securely fasten luminaires to the listed and labeled ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members. The architectural ceiling framing system may be used in lieu of independent support with prior written approval by the ceiling system manufacturer and Authority Having Jurisdiction (AHJ). Luminaires and wiring installed in fire-rated ceiling assemblies shall be independently supported for all applications.
 1. Install recessed flanged luminaires to permit removal from below. Use manufacturer-supplied plaster frames and swing gate supports. Provide independent support as follows:
 - a. Luminaires less than 56 lbs: Provide a minimum of two (2) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires.
 - b. Luminaires 56 lbs or greater: Provide a minimum of four (4) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires. Support luminaire independent of the ceiling system.
 - c. Luminaires larger than eight square feet (8 ft²): Support luminaire independent of the ceiling system.
- B. Do not fasten luminaire supports to piping, ductwork, mechanical equipment, or conduit, unless otherwise noted. Support wires shall be tightly wrapped (minimum of three turns within 3 inches of the connection) and sharply bend to prevent vertical movement.

- C. Support suspended or pendant mounted luminaires independent of ceiling grid with adjustable stainless steel aircraft cables or per luminaire schedule mounting requirements. Suspension assembly and anchors shall be capable of supporting 300 pounds dead load at each suspension point.
- D. Support wire used to independently support luminaires, raceways, and wiring systems shall be distinguishable from ceiling support systems by color (field paint), tagging or equivalent means.
- E. Provide seismic bracing of luminaires per IBC Chapter 16. Design pendant luminaires on a component seismic coefficient (C_c) of 0.67. Design vertical supports with a factor of safety of 4.0. Contractor shall verify the Seismic Hazard Exposure Group and Performance Criteria Factor.
- F. Install lamps in lamp holders of luminaires.
- G. Adjust aimable luminaires to obtain lighting levels on objects and areas as directed to obtain desired lighting levels.
- H. Recessed luminaires and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.

3.2 CONSTRUCTION USE OF PROJECT LUMINAIRES

- A. The Contractor shall provide temporary construction lighting per the requirements of Division 1.
- B. The project luminaires shown on the construction documents shall not be used for temporary construction purposes without providing a plan for Owner approval that addresses energy and luminaire operating hours.

3.3 EMERGENCY LIGHTING UNITS AND EXIT SIGNS

- A. Install units plumb and level.
- B. Aim directional lamp heads as directed.
- C. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.4 RELAMPING

- A. Replace failed LED light engine modules or arrays at completion of work.

3.5 ADJUSTING AND CLEANING

- A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.

- B. Touch up luminaire and pole finish at completion of work.

3.6 OWNER TRAINING

- A. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion, with the Owner's Representative.
- B. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.7 LUMINAIRE SCHEDULE

- A. As shown on the drawings.

END OF SECTION

SECTION 270500 - BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Communications Systems Requirements specifically applicable to Division 27 sections, in addition to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Communications Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Communications Work a finished and working system.
- C. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the Construction Manager's scope statements for complete scope of work description.
- D. Description of Systems include, but are not limited to, the following:
 - 1. Complete Structured Cabling System including, but not limited to:
 - a. Backbone cabling and terminations.
 - b. Horizontal cabling and terminations.
 - c. Information outlets (IOEs) including faceplates, jacks and labeling.
 - d. Equipment racks, cable management, and equipment.
 - e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks.
 - f. Cabling pathways.
 - g. Grounding and bonding
 - h. Testing
 - 2. Extension of existing Paging Systems.
 - 3. Complete Healthcare Communications Systems consisting of localized call-for-assistance devices with audio/video corridor lights. No central annunciation or control terminal included in the scope.
 - 4. Extension of existing CATV coaxial cabling infrastructure to new TV outlet locations.
 - 5. Mounting and patching of wireless access points provided by others.
 - 6. Removal/demolition work and/or relocation and reuse of existing systems and equipment.

7. Low Voltage Communications Wiring (less than +120VAC) as specified and required for proper system control and communications.
8. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
9. Firestopping of penetrations as described in Section 270503.
10. Seismic requirements as described in Section 260548 "Seismic Requirements for Equipment and Supports".

1.3 OWNER FURNISHED PRODUCTS

- A. Active network equipment, routers, switches, etc.
- B. Wireless Access Points (WAP)
- C. Security surveillance cameras. UTP network cabling and above ceiling jack by this contractor.
- D. UPS systems and associated power distribution equipment, rack mounted.

1.4 WORK SEQUENCE

- A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.
- B. Itemize all work and list associated hours and pay scale for each item.

1.5 DIVISION OF WORK BETWEEN ELECTRICAL AND COMMUNICATIONS CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
 1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
 2. "Electrical Contractor" shall also refer to the Contractor listed in Division 27 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
 3. "Technology Contractor" as referred to herein refers to the Contractors listed in Division 27 of this Specification.

4. Low Voltage Technology Wiring: The wiring (less than 120VAC) associated with the Technology Systems, used for analog and/or digital signals between equipment.
5. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation and mounting of the telecommunications/technology outlet. Rough-in shall include conduit from the information outlet backbox to above the lay-in ceiling. Where surface mounted backboxes are required, conduit shall be routed to above the lay-in ceiling

C. General:

1. The purpose of these specifications is to outline typical Electrical and Technology Contractor's work responsibilities as related to technology systems including telecommunications rough-in, conduit, cable tray, power wiring, and low voltage communications and technology wiring. The prime contractor is responsible for all divisions of work.
2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the technology drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the technology drawings but required for the successful operation of the systems shall be the responsibility of the Technology Contractor and included in the Contractor's bid.
3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of technology systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
4. Where the Electrical Contractor is required to install cable tray that will contain low voltage technology wiring, the installation shall not begin until the Technology Contractor has completed a coordination review of the cable tray shop drawing.
5. This Contractor shall establish electrical and technology utility elevations prior to fabrication and installation. The Technology Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
 - a. Lighting Fixtures
 - b. Gravity Flow Piping, including Steam and Condensate
 - c. Sheet Metal
 - d. Electrical Busduct
 - e. Cable Trays, including 12" access space
 - f. Sprinkler Piping and other Piping
 - g. Conduit and Wireway
 - h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Assumes all responsibility for providing and installing cable tray.
3. Responsible for Communications Systems grounding and bonding.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the technology bonding system.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.

- e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
 - 2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
 - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
 - 3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
- B. Participation:
- 1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
 - 2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
 - 3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
- 1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

- 4) Sections of shafts and mechanical and electrical equipment rooms:
1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
 3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
 4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect/Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Architect/Engineer and Owner's Representative. The Architect/Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The Architect/Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect/Engineer.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the Architect/Engineer at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect/Engineer and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.7 QUALITY ASSURANCE

A. Telecommunications Structured Cabling System Standards:

1. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:
 - a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling
 - b. ANSI/TIA-568-0-D - Generic Telecommunications Cabling for Customer Premises
 - 1) 1-D - Commercial Building Telecommunications Standard
 - 2) 2-D - Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 - 3) 3-D - Optical Fiber Cabling Components Standard
 - 4) 4-D - Broadband Coaxial Cabling and Components Standard
 - c. ANSI/TIA-569-E - Telecommunications Pathways and Spaces
 - d. ANSI/TIA-606-C - Administration Standard for Commercial Telecommunications Infrastructure
 - e. ANSI/TIA-607-D - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - f. ANSI/TIA-758-B - Customer-Owned Outside Plant Telecommunications Standard
 - g. ANSI/TIA-862-A - Building Automation Systems Cabling Standard
 - h. ANSI/TIA-942-A - Telecommunications Infrastructure Standard for Data Centers
 - i. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - j. ANSI/TIA-1179 Healthcare Facility Telecommunications Standard
 - k. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding
 - l. NFPA 70 (NEC) - National Electrical Code (Current Edition)
 - m. UL 444 - Standard for Safety for Communications Cable
 - n. Mercy Health: Contractor Guidelines For MTS Low Voltage Structured Cabling. (Latest publication)

B. Refer to individual sections for additional Quality Assurance requirements.

C. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
2. The installing Contractor shall be certified by the manufacturer of the structured cabling system. Certification of Contractor shall have been in place for a minimum of one (1) year prior to bidding this project. Documentation of certification is required at the time of bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.
3. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.
4. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
5. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.
6. The Contractor must have a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) on-staff serving as a project manager. Project shop drawings and test reports shall be stamped by the RCDD or CNIDP.
7. The Contractor shall obtain the services of a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) for the project. The RCDD or CNIDP shall perform the following tasks on the project:
 - a. Review contractor's submittals and stamp the submittals stating the submittals compliance with the contract documents.
 - b. Provide written and dated confirmation of an observation of the contractor's installation activities no less than every 2 weeks during the construction period.
 - c. Provide a final written and dated confirmation of a final construction review prior to testing.
 - d. Review final testing of system and indication that the documented results or transmittal of the results stating the test results compliance with the contract documents.
8. The Contractor shall have certified BICSI installation technicians or CNet CNIT (Certified Network Infrastructure Technician) on staff to perform the following tasks on the project:
 - a. Act as the field superintendent or job foreman with the responsibility of monitoring the daily work of each technician.
 - b. Oversee all testing and termination of cabling.

9. The Contractor shall have certified BICSI Installer 2 or CNet CNCI (Certified Network Cabling Installer) on staff to perform the following tasks:
 - a. Installation and termination of copper cable.
 - b. Installation and termination of optical fiber.
10. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
 - a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.
 - b. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 - c. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic systems on the project.
 - d. A technical resume of experience for the Contractor's project manager and on-site installation supervisor assigned to this project.
 - e. Resume and certification of the RCDD or CNIDP for the project as required by the form at the end of this specification section.
 - f. Resume and certification of the BICSI installation technician or CNet CNIT for the project.

D. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Rogers Arkansas Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all published standards of Mercy Health.
3. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
4. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.
6. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
7. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

E. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.

2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. Pay any charges by the service provider related to the service or change in service to the project.
8. All equipment and materials shall be as approved or listed by the following (unless approval or listing is not applicable to an item by all acceptable manufacturers):
 - a. Factory Mutual
 - b. Underwriters' Laboratories, Inc.

F. Examination of Drawings:

1. The drawings for the technology systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
4. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
5. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
6. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
7. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

H. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.
2. Field conditions that will result in telecommunications drops that exceed the length limitations identified in the contract documents shall be brought to the attention of the Architect/Engineer prior to installation. The cost of reworking cabling that is too long, that was not brought to the written attention of the Architect/Engineer will be borne entirely by the Contractor.
3. This Contractor shall provide the Architect/Engineer with written documentation of any cabling drops that will not be able to use the cable tray (where cable tray is available) due to the resulting cabling lengths. This documentation shall be submitted prior to installation and installation shall not commence until approved by the Architect/Engineer.

1.8 WEB-BASED PROJECT SOFTWARE

- A. The General Contractor shall provide a web-based project software site for the purpose of hosting and managing project communication and documentation until completion of the warranty phase.
- B. The web-based project software shall include, at a minimum, the following features: construction schedule, submittals, RFIs, ASIs, construction change directives, change orders, drawing management, specification management, payment applications, contract modifications, meeting minutes, construction progress photos.
- C. Provide web-based project software user licenses for use by the Architect/Engineer. Access will be provided from the start of the project through the completion of the warranty phase.
- D. At project completion, provide digital archive of entire project in format that is readable by common desktop software applications in format acceptable to Architect/Engineer. Provide data in locked format to prevent further changes.

1.9 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item	Coordination Drawings
27 05 03	Through Penetration Firestopping	
27 05 26	Communications Bonding	
27 05 28	Interior Communications Pathways	Yes
27 05 53	Identification for Communication Systems	
27 11 00	Communication Equipment Rooms	Yes
27 13 00	Backbone Cabling Requirements	
27 15 00	Horizontal Cabling Requirements	
27 17 10	Testing	

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

- Date
- Project title and number
- Contractor's name and address
- Description of items submitted and relevant specification number
- Notations of deviations from the contract documents
- Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

- Date
- Project title and number
- Architect/Engineer
- Contractor and subcontractors' names and addresses
- Supplier and manufacturer's names and addresses
- Description of item submitted (using project nomenclature) and relevant specification number
- Notations of deviations from the contract documents
- Other pertinent data
- Provide space for Contractor's review stamps

3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor shall provide proof of RCDD or CNIDP review on the submittal.
 - d. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - e. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

- f. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
- 6. Submittal Identification and Markings:
 - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
- 7. Schedule submittals to expedite the project. Coordinate submission of related items.
- 8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
- 9. Reproduction of contract documents alone is not acceptable for submittals.
- 10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
- 11. Submittals not required by the contract documents may be returned without review.
- 12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
- 13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
- 14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
- 15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
- 16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 27 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 27 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
 1. Firestopping, including mechanical firestop systems.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
- B. Store materials on the site to prevent damage.
- C. Keep fixtures, equipment and materials clean, dry and free from deleterious conditions.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 27 may require additional warranty requirements for specific equipment or systems.
- B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.
- C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.14 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.15 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.

- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.1 CABLE JACKET RATING

- A. This project requires all cable jackets to carry a plenum rating.

2.2 Refer to individual sections.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 260533. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

- C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.
- D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

A. General:

- 1. Refer to specific Division 27 sections for further requirements.
- 2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
- 3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
- 4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
- 5. All communications cable tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.

B. Protection of cable from foreign materials:

- 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
 1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
 2. Refer to the end of this specification section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
 3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.
- C. Before final payment will be authorized, this Contractor must have completed the following:
 1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
 2. Submitted bound copies of approved shop drawings.
 3. Record documents including edited drawings and specifications accurately reflecting field conditions, inclusive of all project revisions, change orders, and modifications.
 4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
 5. Submitted testing reports for all systems requiring final testing as described herein.
 6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
 7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; submit receipt to Architect/Engineer prior to final payment being approved.

8. Provide System Assurance Warranty certificate for the telecommunications system.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div27.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div27.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.
- E. Refer to the individual specification sections for minimum hours of instruction time for each system.
- F. Operating Instructions:
 1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the Communications Systems.

2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM STARTING AND ADJUSTING

- A. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.
- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.
- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- C. This Contractor shall maintain at the job site, a separate and complete set of technology drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

- D. Record actual routing of all conduits sized 2" or larger.
- E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

3.10 CONSTRUCTION WASTE MANAGEMENT

- A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).
 - 1. This Contractor shall coordinate with the[General Contractor][Construction Manager] to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.
 - 2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor's scope of work. The Contractor shall provide this information to the[General Contractor][Construction Manager] so that it can be incorporated with similar information from all other contractors for the project.
 - a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the[General Contractor][Construction Manager] to establish the preferred calculation method and report the results accordingly.
 - b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.
 - 3. At a minimum, 50% of the construction and demolition debris for this project must be recycled or salvaged.

STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

To assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

1. All cabling pathways (cable tray, ladder rack, conduit sleeves, etc.) are installed and all cabling has been pulled through them.
2. All mechanical firestop products are installed and all other penetrations have been sealed.
3. All telecommunications jacks are installed in the faceplates.
4. All telecommunications cabling is pulled and at least 90% of all jacks have been terminated at the jack and at the telecom room.
5. Telecommunications testing is in progress and at least 50% of testing has been completed.
6. Telecommunications labeling has been provided on at least 50% of each type of component requiring a label.
7. All telecommunications related grounding is complete.
8. All overhead or integrated paging systems, including speakers, back boxes, cabling, and power supplies, and all headend equipment is installed, programmed and operational.
9. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.
10. All access control system equipment, including card readers, conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational.

Prime Contractor: _____ By: _____

Requested Observation Date _____ Today's Date: _____

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

TELECOMMUNICATIONS - PROOF OF CERTIFICATION

There are specific Contractor qualification requirements for this project as defined in Section 270500, which may include Manufacturer Certification and RCDD or CNIDP credentials. This Proof of Certification document, and the supporting documentation require herein, is required to be submitted at the time of bid to show compliance with the requirements of 27 05 00.

Statement of Compliance:

The named Contractor's base bid is a structured cabling solution from the connectivity manufacturer: _____. Named Contractor is trained and certified, under the named manufacturer's formal certification program to provide and install all materials and work required by this project. Further, said Contractor is authorized, by the named manufacturer, to offer all product, labor and system assurance warranties required for this project by these contract documents.

The certification of this named manufacturer is valid, current and in effect as of the bid day of this project, the _____ day of _____, 20____.

The named Contractor is not employing any other sub-contractor on the telecommunications portion of this project that does not also meet this certification requirement.

Contractor Company Name:

Authorized Representative: (print)

Date: _____

Manufacturer Certification Number (if any): _____

If this project requires RCDD certification, complete the following:

RCDD or CNIDP Name: _____

RCDD #: _____ Expiration: _____

Submit the following with the bid:

This form.

Proof of Manufacturer Certification indicated above.

Proof of RCDD or CNIDP status.

END OF SECTION

SECTION 270503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. HCAI - Health Care Access and Information (California)
- J. The Building Officials and Code Administrators National Building Code
- K. 1997 Uniform Building Code
- L. Wisconsin Administrative Code
- M. 2018 International Building Code
- N. NFPA 5000 – Building Construction Safety Code

1.4 SUBMITTALS

- A. Submit under provisions of Section 270500.

- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.
- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
 - 1. Types of penetrating items.
 - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
 - 3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
 - 4. F ratings for each firestop system.
- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.
- F. Submit VOC rating of firestopping material in g/L (less water) with documentation that it meets the limits set forth in SCAQMD Rule 1168.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

1.6 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
 - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:

1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
 - E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.
- 1.7 WARRANTY
- A. Provide one year warranty on parts and labor.
 - B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
 1. 3M; Fire Protection Products Division
 2. Hilti, Inc.
 3. Johns-Manville
 4. Specified Technologies Inc. (S.T.I.)
 5. Spec Seal Firestop Products
 6. Wiremold/Legrand: Flame Stopper
 7. Dow Corning Corp.

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.

- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

a. F Rating = Wall Rating

Penetrating Item	UL System No.
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

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

3.4 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
 - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.

END OF SECTION

SECTION 270505 - TECHNOLOGY DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Technology demolition.

1.2 RELATED WORK

- A. Section 270500 - Basic Communications Systems Requirements.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for terminating, patching and cross connecting of existing telecommunications and security systems shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY OUTLET, BOX, CONDUIT, OR CABLE THAT MUST BE REMOVED.
- B. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS AND SCOPE OF WORK.
- C. Whenever possible, the Contractor shall coil existing cable above ceiling for re-termination if cable length will allow. Re-terminated cables shall be tested for wire map and continuity.
- D. Where walls, ceilings, structures, etc., are indicated as being renovated on general drawings, the Contractor shall be responsible for the removal of all technology equipment including but not limited to: copper, fiber and coaxial cable, faceplates and jacks, raceways, racking and equipment mounted to the racking, etc., from the renovated area.
- E. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.

- F. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area.
- G. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and technology service to avoid conflicts.

3.2 PREPARATION

- A. Not all services within the building will be inactive or abandoned. Verify abandonment status with the building owner, General Contractor and Architect/Engineer prior to demolition.
- B. Prior to commencing with demolition, a proposed implementation narrative with schedule shall be submitted to the Architect/Engineer for approval.
- C. The contractor shall provide proof that only qualified personnel with extensive telecommunications experience will perform the demolition. No laborers will be allowed in the cable removal process.
- D. The contractor shall coordinate with owner to verify all cabling, patch cords and cross connects have been removed from active equipment that is to remain during the duration of the renovation.
- E. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on active equipment, use technicians experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.

3.3 DEMOLITION AND EXTENSION OF EXISTING TECHNOLOGY WORK

- A. Demolish and extend existing technology work under provisions of Division 1 of Architectural Specifications and this Section.
- B. Some cabling within the ceiling space may serve other building tenants; care shall be exercised to prevent service interrupts.
- C. Remove, relocate, and extend existing installations to accommodate new construction.
- D. Remove abandoned low voltage cabling and raceway to source of cabling according to the NEC. Refer to the NEC for definition of Abandoned Communications Cabling.
- E. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.
- F. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is removed. Provide blank cover for abandoned outlets that are not removed.

- G. Disconnect and remove abandoned patch panels, blocks and other distribution equipment.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing technology installations that remain active. Modify installation or provide access panels as appropriate.
- J. Extend existing installations using materials and methods compatible with existing technology installations, or as specified.
- K. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- L. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or are to be reused.
- B. Patch panels, blocks and other connectivity equipment: Clean exposed surfaces and check tightness of connections. Re-terminate any loose connections; the contractor shall notify the Architect/Engineer of any permanently damaged or unusable equipment.
- C. TECHNOLOGY ITEMS (E.G., PATCH PANELS, EQUIPMENT RACKS, JACKS, FACEPLATES, BLOCKS, CABLING, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.5 INSTALLATION

- A. Install relocated materials and equipment under the provisions of applicable Division 27 specifications.

END OF SECTION

SECTION 270528 - INTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete wire mesh support systems, conduits, sleeves, innerduct, etc. for an interior cabling plant as shown on the drawings.

1.2 RELATED WORK

- A. Section 260533 - Conduit and Boxes
- B. Section 270500 - Basic Communications Systems Requirements
- C. Section 270526 - Communications Bonding

1.3 QUALITY ASSURANCE

- A. Refer to Section 270500 for requirements.

1.4 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NEMA VE 2-2000 - Cable Tray Installation Guidelines

1.5 SUBMITTALS

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
 - 2. Manufacturer's installation instructions.

1.6 DRAWINGS

- A. The drawings, which constitute a part of these specifications, indicate the general route of the wire mesh support systems, conduit, sleeves, etc. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Refer to Section 26 05 33 for conduit requirements for this project.

2.2 CABLE HANGERS AND SUPPORTS

- A. Provide a non-continuous cable support system suitable for use with open cable.
- B. Cable Hooks:
 - 1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.
 - 2. All cable hook mounting hardware shall be recessed to prevent damage to cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.
 - 3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use.
- C. Cable Hangers:
 - 1. Adjustable, non-continuous cable support slings for use with low voltage cabling.
 - 2. Steel and woven laminate construction, rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.
 - 3. Sling length shall be adjustable to a capacity of 425 4-pair UTP cables.
 - 4. Cabling hanger load limit shall be 100 lbs per foot.
 - 5. Manufacturer:
 - a. Erico Caddy
 - b. CableCat CAT425
 - c. Arlington Fittings TI Series
 - d. Or approved equal.

PART 3 - EXECUTION

3.1 CABLE HOOK SUPPORT SYSTEM

- A. In areas where cabling is not supported by cable tray, ladder rack, enclosed wireway or installed in conduit, such cabling shall be supported by an approved cable hook support system.
- B. Refer to manufacturer's requirements for allowable fill capacity for selected cable hook. In no case shall a 40% fill capacity be exceeded.
- C. Cable hooks shall be securely mounted per manufacturer's instructions. In no case shall the side-to-side travel of any cable hook exceed 6".
- D. Cable hooks shall be selected based on the contractor's cable routing. Hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.

- E. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet.
- F. The resting and supporting of cabling on structural members shall not meet the requirements for cabling support specified herein.
- G. The use of tie-wraps or hook and loop type fasteners is specifically prohibited as a substitute for cable hooks specified herein.

3.2 CONDUIT AND CABLE ROUTING

- A. Refer to Section 260533 for additional requirements.
- B. All conduits shall be reamed and shall be installed with a nylon bushing.
- C. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.
- D. No conduit or sleeve containing more than two (2) cables shall exceed 40% fill ratio, regardless of length.
- E. Any conduit exceeding 90' in length or containing more than two (2) 90-degree bends shall contain a pull box sized per ANSI/TIA/EIA 569 requirements.
 - 1. A separate pull box is required for each 90' (or greater) length section.
 - 2. A separate pull box is required after any two (2) consecutive 90-degree bends.
 - 3. Pull box shall be located in an area that maintains accessibility of box, including the ability to remove box lid without removal or relocation of any other materials.
- F. Any conduit with bends totaling 90 degrees or more shall have the fill capacity derated by 15% for each 90 degrees of cumulative bend.
- G. Cables installed in any conduits that do not meet the above requirements shall be replaced at the Contractor's expense, after the conduit condition has been remedied.

3.3 ATTACHMENT TO METAL DECKING

- A. Where supports for cable trays and cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center. This 25-lb. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

END OF SECTION

SECTION 270553 - IDENTIFICATION FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the identification requirements relating to the structured cabling system and its termination components and related subsystems.
- B. Identification and labeling.

1.2 RELATED WORK

- A. Section 270500 - Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

- A. Refer to Section 270500 for relevant standards.
- B. Perform all work in accordance with Mercy Health, Contractor Guidelines for MTS Low Voltage Structured Cabling (latest publication).

1.4 SUBMITTALS

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Documentation of labeling scheme.

PART 2 - PRODUCTS

2.1 LABELING

- A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.
- B. Insert labels shall meet the requirements of UL 969 for legibility, defacement and general exposure.
- C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, typeface and attachment method.
- D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.
 - 1. All Code 39 bar codes shall have a ratio between 2.5:1 and 3.0:1. Provide a minimum "quiet zone" of 0.25" on each side of the bar code.

2. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.

E. Color Code: Observe the following requirements for color coding:

1. Labels on each end of a cable shall be the same color for each termination.
2. Labels for cross-connects shall be two different colors at each termination fields, representative of the color of that field.
3. Orange (Pantone 15C) shall be used for the demarcation point.
4. Green (Pantone 353C) shall be used for the termination point of network connection on the facility side of the demarc.
5. Purple (Pantone 264C) shall be used to identify the termination of cables from common equipment (PBX, computers, LANS, etc.)
6. White shall be used to identify the first-level backbone termination in the main cross-connect.
7. Gray (Pantone 422C) shall be used to identify the second-level backbone termination in the main cross-connect.
8. Blue (Pantone 291C) shall be used to identify the termination of station cabling at the telecommunications closet and/or equipment room end of the cable.
9. Brown (Pantone 465C) shall be used to identify the termination of the interbuilding backbone cable terminations.
10. Yellow (Pantone 101C) shall be used to identify the termination of auxiliary circuits, alarms, maintenance, security, etc.
11. Red (Pantone 184C) shall be used to identify the termination of key telephone systems.
12. In facilities that do not contain a main cross-connect, the color white may be used to identify second-level backbone terminations.

F. Tag all CAT 3, CAT 5E, CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system:

1. (Telecom Room Number) - (Patch Panel Letter) - (Patch Panel Port Number).
2. "Telecom Room Number" shall be as indicated on the drawings.
3. "Patch Panel Letter" shall start with 'A' for the top modular patch panel, increasing sequentially from top to bottom across the equipment rack.
4. "Patch Panel Port Number" shall start with '1' for the upper left port in each modular patch panel, increasing sequentially from left to right and top to bottom across the modular patch panel face.
5. Example #1: MC/1-A3 indicates the third modular patch panel port in modular patch panel 'A' in Main Equipment Room (MC/1).
6. Example #2: HC/2-C39 indicates the thirty-ninth modular patch panel port in modular patch panel C in Horizontal Cross-Connect room (HC/2).

2.2 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 270500 and Division 1. Documentation shall include the items detailed in the subsections below.

2. All documentation, including hard copy and electronic forms shall become the property of the Owner.

B. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION

3.1 IDENTIFICATION AND LABELING

A. Cable Labeling:

1. Horizontal cables shall be labeled at each end.
 - a. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color may include blue with a white stripe to indicate the higher performance class station cabling.
2. Backbone cables shall be labeled at each end.
 - a. Provide additional cable labeling at each manhole and pull box.
 - b. Cables that are routed through multiple pathway segments shall contain reference to all pathway segments in the pathway linkage field.
 - c. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color, may include blue with a white stripe to indicate the higher performance class station cabling.

B. Information Outlet Labeling: Tag all voice and data jacks as defined herein.

C. Grounding/Bonding Labeling:

1. The PBB shall be labeled "PBB." There shall be only one PBB in the facility.
2. Label all TBB conductors connecting to the PBB with a unique label, located at both ends of the TBB.
3. Each SBB shall be labeled with a unique label.
4. All TBB conductors connecting to the SBB shall be labeled uniquely at each end of the cable.

END OF SECTION

SECTION 271100 - COMMUNICATION EQUIPMENT ROOMS (CER)

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements related to furnishing and installing equipment for communication equipment rooms.

1.2 RELATED WORK

- A. Section 270500 - Basic Communications Systems Requirements
- B. Section 270526 - Communications Bonding
- C. Section 270528 - Interior Communication Pathways
- D. Section 271500 - Horizontal Cabling Requirements

1.3 QUALITY ASSURANCE

- A. Refer to Section 270500 for applicable standards.

1.4 SUBMITTALS

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

PART 2 - PRODUCTS

2.1 EQUIPMENT GROUNDING

- A. Refer to specification section 270526 for grounding requirements.
- B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

2.2 EQUIPMENT RACKS AND CABINETS

- A. Where identified on the drawings in Communication Equipment Rooms, equipment racks and/or equipment cabinets shall be furnished and installed by the Contractor to house cable termination components (e.g., copper, optical fiber, coax) and network electronics.

B. The equipment rack shall conform to the following requirements:

1. Standard TIA/EIA 19" Floor Rack:

- a. Equipment rack shall be 84" in height, self-supporting and provide a useable mounting height of 45 rack units (RU) (1 RU = 1 3/4").
- b. Channel uprights shall be spaced to accommodate industry standard 19" mounting.
- c. Equipment rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per TIA/EIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
- d. Equipment racks shall be provided with a supply of spare screws (minimum of 24).
- e. Equipment racks shall be provided with a ground bar and #6 AWG ground lug.
- f. Provide all mounting hardware and accessories as required for a complete installation.

2.3 CABLE MANAGEMENT - VERTICAL AND HORIZONTAL

A. Equipment Racks:

1. Equipment racks shall be equipped with vertical and horizontal cable management hardware in the form of rings and guides. Racks shall incorporate vertical and horizontal covers, to allow an orderly, hidden, routing of copper, optical fiber, and coax jumpers from the modular patch panels and/or 110-type termination blocks to the customer provided network electronics. Vertical and horizontal cable management hardware shall be as follows:
 - a. Horizontal cable management hardware shall be 16 gauge cold rolled steel construction with six (6) pass-thru holes and seven (7) front-mounted 3.5" steel rod D-rings. Provide with cover designed to conceal and protect cable.
 - b. At a minimum, horizontal cable management hardware shall be positioned above and below (a) each grouping of two rows of jacks on modular patch panels, and (b) above and below each optical fiber patch panel and (c) each grouping of two rows of F-type connectors on coax patch panels.
 - c. Vertical cable management hardware shall provide for cable routing on front and rear of each rack and be 14" deep x 6" wide (minimum). Where multiple equipment racks are to be installed, this hardware shall be mounted between the uprights of adjacent equipment racks. Equipment rack uprights and the spacers shall be secured together per manufacturer's recommendations. Provide with cover designed to conceal and protect cable.
2. Each equipment rack shall be supplied with a minimum of 12 releasable (e.g., "hook and loop") cable support ties.

3. Where cable termination hardware is wall-mounted, the Contractor shall be responsible for establishing a cable pathway for jumpers routed from the equipment rack(s) to the wall. This shall be in the form of slotted ducts or troughs. Routing of jumpers via the overhead cable tray or ladder rack system is NOT acceptable. The proposed method shall be included in the submittals required by this document and shall be approved by the Architect/Engineer prior to installation.

2.4 PATCH PANELS

- A. Where identified on the drawings in Communication Equipment Rooms, modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.
- B. Copper cabling shall be terminated in Communication Equipment Rooms on modular patch panels consisting of a modular connector system incorporating modular jacks meeting the specifications for the jacks detailed in Section 271500.
- C. The largest single modular patch panel configuration shall not exceed 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12 jacks. High-density modular patch panels will not be accepted.
- D. The modular patch panel blocks shall have the ability to seat and cut eight (8) conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Modular patch panel blocks shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.
- E. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

2.5 OPTICAL FIBER PANELS

- A. All terminated optical fibers shall be mated to simplex LC-type couplings mounted on enclosed fiber distribution cabinets. Couplings shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g., "FDDI Connector"), Biconic, FC, and MT-RJ by changing panels on which connector couplings are mounted.
- B. The fiber distribution cabinet shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings, including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor.

- C. The fiber distribution cabinet shall be an enclosed assembly affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to conceal and protect the optical fiber couplings, connectors, and cable.
- D. Access to the inside of the fiber distribution cabinet's enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the fiber distribution cabinet to gain entry will not be accepted.
- E. The fiber distribution cabinet's enclosure shall provide for strain relief of incoming optical fiber cables and shall incorporate radius control mechanisms to limit bending of the optical fiber to the manufacturer's recommended minimums or 1/2", whichever is larger.
- F. All fiber distribution cabinets shall provide protection to both the "facilities" and "user" side of the coupling. The fiber distribution cabinet's enclosure shall be configured to require front access only when patching. The incoming optical fiber cables (e.g., backbone, riser, horizontal, etc.) shall not be accessible from the patching area of the panel. The fiber distribution cabinet's enclosure shall provide a physical barrier to access such optical fiber cables.
- G. Where "Loose Buffered" cables are installed, the 250 um coated optical fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtailed") or (2) the use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering, an Aramid (e.g., Kevlar) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250 um coated optical fibers shall not be permitted.
- H. Fiber distribution cabinets for horizontal cabling: Where optical fiber horizontal cabling is to be terminated, the enclosure shall be compliant to all the above requirements plus the enclosure shall incorporate a storage mechanism designed to allow simplified identification, access to and termination of individual optical fibers. This may be in the form of a storage cassette, tray or other appropriate mechanism.

2.6 OPTICAL FIBER COUPLERS/ADAPTERS

- A. Optical Fiber Couplings (LC-type) (Multimode/Singlemode):
 - 1. LC-type optical fiber couplings shall be used to terminate optical fiber backbone cable on fiber distribution cabinet panels in communication equipment rooms. Horizontal optical fiber cables shall also be terminated using optical fiber couplings at their designated work area locations on information outlet faceplates for "fiber to the desk."
 - 2. LC-type optical fiber couplings shall be snap-type with locking washer and nut.
 - 3. LC-type optical fiber couplings shall incorporate domed zirconia ferrule and shall utilize a PC polish to ensure fiber-to-fiber physical contact for low loss and reflections.

4. LC-type optical fiber couplings shall accept 125-micron outside diameter multimode fiber.
5. The attenuation per mated pair shall not exceed 0.7 dB (individual) and 0.5 dB (average). Connectors shall sustain a minimum of 200 mating cycles per TIA/EIA-455-21 without violating specifications.
6. LC-type optical fiber couplings shall meet the following performance criteria:

Test Procedure	Maximum Attenuation Change
Cable Retention (FOTP-6)	0.2 dB
Durability (FOTP-21)	0.2 dB
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

7. Performance Requirements:
 - a. Length: 2 inches
 - b. Operating Temperature: -40C to 85C
8. Basis of Design:
 - a. Corning

2.7 LADDER RACK

- A. Provide complete ladder rack system including metallic ladder rack, splice connectors, fastening hardware and other miscellaneous materials as required for a complete installation per manufacturer's recommendations.
- B. Tubing Style Ladder Rack:
 1. Rolled steel siderail stringer, minimum 1.5" stringer height, 9" spaced welded rungs.
 2. Steel shall meet the requirements of ASTM A1011 SS Grade 33.
 3. Loading limits shall be 185 lbs/ft for 4 ft spans.
- C. Ladder rack finish shall be flat black powder coat.
- D. Basis of Design: Chatsworth Products Inc.

Ladder Rack: 12" wide #10250-712

Rack to Runway mounting plate: Part #10595-712.

Wall Angle Support kit: Part #11421-712.

Junction Splice kit: Part #11302-001

Cable retaining post: Part # 10596-708

Corner brackets: Part #11959-724

No approved substitutions

2.8 POWER STRIPS

- A. Mount owner provided power strips on all equipment racks, unless noted otherwise. These power strips shall have the following characteristics:

- 1. Standard Rack Mount:

- a. TIA/EIA 19" equipment rack mountable.
- b. Be equipped with a power cord.

PART 3 - EXECUTION

3.1 EQUIPMENT RACKS

- A. Equipment racks shall be furnished and installed as shown on the drawings.
- B. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. The rack shall be stabilized by extending a brace to the wall. Alternately, overhead ladder rack by which the cabling accesses the equipment rack(s) may provide this function.
- C. A space between the rack upright and the wall (approximately 4") should be provided to allow for cabling in that area. The rear of the rack should be approximately 40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40" workspace in front of the rack is also required. Locations where these guidelines cannot be followed should be brought to the attention of the Architect/Engineer for resolution prior to installation.
- D. All hardware and equipment is to be mounted between 18" and 79" above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware should be reviewed and approved by the Architect/Engineer and Site Coordinator(s) prior to installation.
- E. Equipment racks shall be equipped with cable management hardware as to allow an orderly and secure routing of optical fiber and/or copper cabling to the optical fiber distribution cabinets and/or modular patch panels. At minimum, one such horizontal jumper management panel shall be placed below each optical fiber distribution cabinet installed by the Contractor. Additional Jumper Management panels may be required pending installation of other cable types on the equipment rack.
- F. Each rack shall be grounded to the telecommunications ground bar (GND) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket) directly or via an adjacent grounded equipment rack. Refer to grounding requirements below.

3.2 LADDER RACK

- A. Provide support for ladder rack on 4 ft centers.
- B. Maintain a 1.5 safety factor on all load limits specified herein.

- C. Ladder rack support shall be by 5/8" diameter threaded rod when ceiling mounted. Ladder rack requiring wall mounting shall utilize accessories supplied by the ladder rack manufacturer specifically for the purpose of wall mounting ladder rack.

3.3 GROUNDING

- A. Provide a complete grounding system in accordance with the requirements of Section 270526.

3.4 OPTICAL FIBER TERMINATION

- A. All fiber slack shall be neatly coiled within fiber splice enclosures or splice trays. No slack loops shall be allowed external to the enclosure.
- B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.
- C. Each cable shall be clearly labeled at the entrance to all enclosures.
- D. A maximum of 12 strands shall be spliced in any tray.

3.5 CONDUITS AND CABLE ROUTING

- A. Refer to Section 260533 for additional requirements.
- B. Where conduits enter a telecommunications room, conduits shall be terminated on the wall where shown on the contract documents. Conduits entering the room from the floor shall extend 3" above the floor slab.
- C. Where cabling rises vertically in a telecommunications rooms, provide vertical cable management to support the cabling from floor to ceiling level.
- D. All conduits shall be reamed and shall be installed with a nylon bushing.
- E. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.

END OF SECTION

SECTION 271300 - BACKBONE CABLING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing backbone communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of both optical fiber and/or copper cabling.

1.2 RELATED WORK

- A. Section 270500 - Basic Technology Systems Requirements.
- B. Section 271500 - Horizontal Cabling Requirements.
- C. Section 271720 - Structured Cabling System Warranty.

1.3 QUALITY ASSURANCE

- A. Refer to Section 270500 for relevant standards.

1.4 SUBMITTALS

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The basis of design is listed herein. Refer to Section 271720 for additional acceptable manufacturers.

2.2 OPTICAL FIBER BACKBONE - INSIDE PLANT

- A. Multimode (MM)/Singlemode (SM):
 - 1. This optical fiber backbone cable shall be suitable for installation in building riser systems, in conduit, in cable tray and/or in innerduct.
 - 2. Optical fiber cable materials shall be all dielectric (no conductive material).
 - 3. Optical fiber cable shall carry an OFNR (optical fiber non-conductive riser) or OFNP (optical fiber non-conductive plenum) rating. Refer to Section 270500 for project requirements.
 - 4. Optical fiber cable shall be interlocking armored cable.

5. Outer Sheath: The outer sheath shall be marked with the manufacturer's name, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet.
6. Temperature Range:
 - a. Storage: -40C to +70C (no irreversible change in attenuation).
 - b. Operating: -40C to +70C.
7. Humidity Range: 0% to 100%.
8. Maximum Tensile Strength (greater than or equal to 12 fibers):
 - a. During Installation: 1332 N (300 lb. force) (no irreversible change in attenuation).
 - b. Long-Term: 600 N (135 lb. force).
9. Maximum Tensile Strength (less than or equal to 6 fibers):
 - a. During Installation: 1000 N (225 lb. force) (no irreversible change in attenuation).
 - b. Long-Term: 100 N (67 lb. force).
10. Bending Radius:
 - a. During Installation: 20 times cable diameter.
 - b. No Load: 10 times cable diameter.

B. Basis of Design (OM3 Multimode):

1. Corning FREEDM One #012T8P-31180-A3.
2. Additional acceptable manufacturers.
 - a. No approved alternate.

2.3 COPPER BACKBONE - INSIDE PLANT

A. CAT 3 Backbone Cable:

1. The CAT 3 backbone cable shall link Communication Equipment Room serving the renovation area. The CAT 3 backbone cable shall be terminated on rack-mounted 110-type termination patch panel.
2. CAT 3 backbone cable shall incorporate 24 AWG solid annealed copper conductors insulated with a polyvinyl chloride (PVC) CMR or thermoplastic CMP plenum rated skin. Refer to Section 270500 for project requirements. Conductors shall be twisted to form pairs and be fully color-coded.
3. Conductors shall be identified by the insulation color of each conductor. The color code shall follow the industry standard composed of 10 distinctive colors to identify 25-pairs in accordance with ICEA publication S-80-576-1988. Marking of each mate of the primary conductor in a pair with the color of that primary conductor is optional.
4. CAT 3 backbone cable shall meet the TIA/EIA Category 3 performance requirements.

5. When CAT 3 backbone cables of larger than 25-pairs are required, the core shall be assembled into 25-pair sub-units, each color-coded in accordance with ICEA publication S-80-576-1988. CAT 3 backbone cables with over 600-pair shall have 25-pair binder groups combined into super units. These super units shall be wrapped with a solid color thread that follows the primary color scheme of white, red, black, yellow and violet. Binder color code integrity shall be maintained wherever cables are spliced.
6. CAT 3 backbone cables shall contain an overall corrugated, coated aluminum shield that is electrically continuous over its entire length.
7. CAT 3 backbone cables shall be Air Core with an 8-mil ALVYN Sheath.
8. Basis of Design:
 - a. Belden
 - b. Additional acceptable manufactures
 - 1) Mohawk
 - 2) Berk-Tek
 - 3) Superior Essex

B. RG11 Cable - Broadband Coaxial Cable:

1. Basic Construction:
 - a. Center conductor: 14 AWG bare copper covered steel; 0.064" OD (nominal); foamed polyethylene dielectric.
 - b. Four Layer Shield:
 - 1) Innershield: Aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
 - 2) Second shield: 60% 34 AWG bare aluminum braid wire.
 - 3) Third shield: non-bonded aluminum foil tape.
 - 4) Outer shield: 40% 34 AWG bare aluminum braid wire.
 - c. Outer jacket: Refer to Section 270500 for plenum or non-plenum rating requirements.
 - d. Impedance: 75 ohms.
 - e. Velocity of propagation: 83%.
 - f. Maximum attenuation (per 100 feet):
 - 1) at 55-MHz: 0.97 dB.
 - 2) at 450-MHz: 2.65 dB.
 - 3) at 750-MHz: 3.50 dB.
 - 4) at 1000-MHz: 4.23 dB.
2. Acceptable Manufacturers:
 - a. Belden 1153A plenum.
 - b. CommScope.
 - c. West Penn.

2.4 OPTICAL FIBER CONNECTORS

A. Optical Fiber Pigtails (Multimode):

1. Single-fiber fiber optic pigtails shall be constructed from 50/125 um multimode (MM) optical fiber of the same grade as the multimode fiber optic backbone cable utilizing tight buffer construction.
2. Fiber optic pigtails shall be factory terminated with a ceramic tipped LC-type connector on one end and shall be a minimum of 5 feet (1.5m) in length or as indicated on the drawings. Channels shall be of equal length.
3. Connector body shall be of materials similar to that used in the proposed couplings. Refer to Section 271500 for connector performance requirements.
4. Provide in quantity to terminate all backbone fiber optic cable strands on each end.
5. Basis of Design:
 - a. Multimode Optical Fiber Pigtails shall be from the same manufacturer as used for the fiber optic termination equipment.

Test Procedure	Maximum Attenuation Change
Cable Retention (FOTP-6)	0.2dB
Durability (FOTP-21)	0.2dB
Impact (FOTP-2)	0.2dB
Thermal Shock (FOTP-3)	0.2dB
Humidity (FOTP-5)	0.2dB

B. Optical Fiber Connectors (LC-type) (Multimode/Singlemode):

1. LC-type Optical Fiber Connectors: Shall be used to terminate optical fiber in communication equipment rooms.
2. LC-type optical fiber connector plugs shall be snap-type with an integrated pull-proof design.
3. LC-type optical fiber connector plugs shall incorporate a zirconium ceramic ferrule and shall utilize a factory pre-polish end face to ensure fiber-to-fiber physical contact for low loss and reflections.
4. LC-type optical fiber connector plugs shall accept 1.6mm - 2.0mm and 3.0mm outside diameter fiber.
5. The average insertion loss is 0.3db for multimode and single mode connectors
6. LC-type optical fiber connector plugs shall meet the following performance criteria:

Test Procedure	Maximum Attenuation Change
Cable Retention (FOTP-6)	0.2dB
Durability (FOTP-21)	0.2dB
Impact (FOTP-2)	0.2dB
Thermal Shock (FOTP-3)	0.2dB
Humidity (FOTP-5)	0.2dB

7. Additional Performance Requirements:

- a. Length: 2.23 inches
- b. Operating Temperature: -40C to 85C

8. Basis of Design:

- a. Optical fiber connectors shall be from the same manufacturer as fiber cable manufacturer.

2.5 OPTICAL FIBER BACKBONE PERFORMANCE

A. Multimode (MM):

- 1. Fiber Type: Multimode; doped silica core surrounded by a concentric glass cladding.
- 2. Index Profile: Graded Index.
- 3. Transmission Windows: 850-nm and 1300-nm.
- 4. Core Diameter (nom): 50-um (microns) Less than or equal to 2.5.
- 5. Cladding Diameter: 125-um $\pm$ 1.
- 6. Core-clad Concentricity: Less than or equal to 1.0-um.
- 7. Cladding Non-circularity: Less than or equal to 1.0%.
- 8. Fiber Coating Diameter:
 - a. 245-um $\pm$ 10 (primary coating).
 - b. 900-um (nominal) secondary coating (tight buffer)
 - c. All coatings shall be mechanically strippable without damaging the optical fiber.
- 9. Attenuation (maximum @ 23 $\pm$ 5C; backbone):
 - a. @ 850-nm: 3.5 dB/km.
 - b. @ 1300-nm: 1.5 dB/km.
 - c. @ 1300-nm thru 1380-nm: 1.0dB/km
 - 1) When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation over the rated temperature range of the optical cable shall not exceed 0.50 dB/km with 80% of the measured fibers not exceeding 0.25 dB/km.
- 10. Bandwidth (minimum):
 - a. @ 850-nm: 2000 MHz*km. (OM3)
 - b. @ 1300-nm: 500 MHz*km. (OM3)
 - c. @ 850-nm: 4700 MHz*km. (OM4)

11. No optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION REQUIREMENTS

- A. Cable slack shall be provided in each backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure.
- B. A minimum of 5 meters (approximately 15 feet) of slack cable (each cable if applicable) shall be coiled and secured at both ends located in the entrance room, telecommunications room or main equipment room, for backbone and intra-building cable.
- C. Where exposed, all backbone fiber optic cable shall be installed in protective inner duct. This includes areas where the cable is routed in cable tray and where making a transition between paths (e.g., between conduit and cable tray or into equipment racks). The inner duct should extend into the termination and/or storage enclosure(s) at system endpoints.

3.2 CROSS-CONNECTS

- A. The Owner will be responsible for all cross-connects between the data backbone cabling and network electronics and between the data network electronics and horizontal cabling.
- B. The Owner shall be responsible for the cross-connect wiring between the horizontal and backbone voice cabling.
 1. All four (4) pairs of the horizontal cable shall be terminated on modular patch panels. Two (2) pairs of the horizontal cable shall be cross-connected to the backbone cable. Refer to the drawings for requirements of the 110 to RJ-45 cross connect cable.
 2. All four (4) pairs in each horizontal cable shall be terminated on 110-type termination blocks in a field dedicated for horizontal cabling. Two (2) pairs of the horizontal cable shall be cross-connected to the backbone cable. 2-pair cross-connect wire, color-coded to identify each pair, shall be used. The 25TH pair position (50th, 75th, etc.) of each riser voice block shall remain vacant.
 3. Fastening cables directly to support brackets with wire or plastic ties will not be accepted. All cabling shall be neatly laced, dressed and supported. Avaya 88A retainer clips (or equivalent) shall be used on each 110-type termination block to secure jumper wires on the wiring block(s).

- C. This Contractor shall not be responsible for cross-connects between the cabling terminations at the entrance room and the telephone utility network point-of-presence. It shall be the responsibility of the Contractor, to work with the Owner and provide the necessary assistance to allow Owner and/or telephone company personnel to make the necessary connections to establish service on the new cable system. These activities include, but are not limited to cross-connect documentation, general wiring overview and cable pair identification.

END OF SECTION

SECTION 271500 - HORIZONTAL CABLING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of copper cabling.

1.2 RELATED WORK

- A. Section 270500 - Basic Communications Systems Requirements
- B. Section 271720 - Structured Cabling System Warranty

1.3 QUALITY ASSURANCE

- A. Refer to Section 270500 for relevant standards and plenum or non-plenum cable requirements.
- B. The channel shall be required to meet the performance requirements indicated herein. The manufacturer shall warranty the performance of their system to the required performance (and not just to the Standard, should the required performance exceed the Standard).
- C. Specific components of the channel shall be required, at a minimum, to meet the Standard component requirements for that particular component.
- D. The installing contractor must be certified by the manufacturer of the structured cabling system.

1.4 SUBMITTALS

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLE

- A. CAT 6 Cable:
 - 1. The horizontal cable requirements must be met as well as the following channel requirements.

2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.
3. Performance Tests shall be conducted using swept frequency testing through 250 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 250 MHz is not acceptable.
4. Performance data shall be characterized as "Guaranteed Headroom" and shall be guaranteed by the manufacturer to perform at guaranteed margins over ANSI/TIA/EIA-568-C.2. Performance data that is not warranted by the manufacturer will not be considered.
5. The structured cabling and connectivity must be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed below. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.
6. The 4-connector channel performance margins listed in the below criteria shall be guaranteed minimum margins above ANSI/TIA/EIA-568-C.2 with electrical parameters between 1-250 MHz.
 - a. Insertion Loss: 14.0%
 - b. NEXT: 7.0 dB
 - c. PS NEXT: 8.0 dB
 - d. ACR-F (ELFEXT): 8.0 dB
 - e. PS ACR-F (PS ELFEXT): 8.0 dB
 - f. Return Loss: 4.0 dB
7. The jacket color for CAT 6 cable shall be **blue** for data applications.
8. Basis of Design:
 - a. General Cable "Genspeed" 5350 #7131800.
 - b. Additional acceptable manufacturers:
 - 1) No approved substitution

B. CAT 6A Cable:

1. The horizontal cable requirements must be met, as well as the following channel requirements.
2. CAT 6A cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.
3. Cable shall exceed transmission requirements listed in ANSI/TIA/EIA-568-C.2. Performance tests shall be conducted using swept frequency testing through 500 MHz for the channel. All numbers given are for a 4-connection channel.
4. Performance tests shall be conducted using swept frequency testing through 500 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 500 MHz is not acceptable.

5. Performance data shall be provided by third-party independent testing laboratories only. Testing data shall be submitted on the third-party testing laboratory letterhead. Test data will only be accepted if it displays testing as a channel. Electrical characteristics of the performance of the cable itself will not satisfy this requirement.
6. The structured cabling and connectivity may be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed below. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.
7. The 4-connector channel performance margins listed in the below criteria shall be guaranteed minimum margins above ANSI/TIA/EIA-568-C.2 with electrical parameters between 1-500 MHz.
 - a. Insertion Loss: 3%
 - b. NEXT: 2 dB
 - c. PS NEXT: 3 dB
 - d. PSA NEXT: 3 dB
 - e. PSA NEXT (Average):
 - f. ACR-F: 2 dB
 - g. PS ACR-F: 3 dB
 - h. PSA ACR-F: 3 dB
 - i. PSA ACR-F (Average): 3 dB
 - j. Return Loss: 2dB
8. The jacket color for CAT 6A cable shall be white for Wireless Access Point (WAP) applications.
9. Basis of Design:
 - a. General Cable #7141850
 - b. Additional acceptable manufacturers:
 - 1) No approved substitution

2.2 CONNECTORS/COUPLERS/ADAPTERS

- A. Refer to Section 271100 for requirements and 27 13 00 for requirements.
- B. Coax (F-Connector):
 1. RG-6 and RG-11 coax cable shall be terminated at the work area and at communication equipment rooms in a male F-type connector.
 2. The male F-type connector shall:
 - a. Be matched to the RG-6 and RG-11 coax cable type proposed by the Contractor.
 - b. Be a single-piece F-type connector.
 - c. Incorporate a 1/2" crimp ring which uses hex crimp.

3. The male F-type connectors shall be mated to female/female feed-thru couplings at both the information outlet and modular patch panel locations. These couplings shall be matched to the male F-type connector. Couplings shall be of sufficient length as to allow for the male F-type connector to fully seat (both sides).

2.3 FACEPLATES/JACKS

A. CAT 6 Jacks:

1. CAT 6 horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.
2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.
3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
4. Where standalone CAT 6 only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.
5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.
6. All modular jacks will be fitted with a dust cover. Modular jacks shall incorporate a dust cover that fits over and/or into the modular jack opening. The dust cover shall be designed to remain with the modular jack assembly when the modular jack is in use. No damage to the modular jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the modular jack pinning, will not be accepted.
7. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall:
 - a. Match the receptacle color used for other utilities in the building, or
 - b. When installed in surface raceway (if applicable), match the color of that raceway.
8. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:
 - a. Be a low-profile assembly.
 - b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.
 - c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.

- d. Incorporate a shroud that protects the optical fiber couplings from impact damage.
- 9. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.
 - 10. The CAT 6 modular jacks shall be non-keyed 8-pin modular jacks.
 - 11. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.
 - 12. CAT 6 modular jacks shall be pinned per TIA-568B.
 - 13. CAT 6 termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:
 - a. ANSI/TIA/EIA-568-A-5
 - b. ANSI/TIA/EIA-568A
 - c. ISO/IEC 11801
 - d. IEC 603-7
 - e. FCC PART 68 SUBPART F
 - 14. The color for CAT 6 jacks shall be yellow for data applications.
- B. Cat 6A Jacks:
- 1. CAT 6A horizontal cable shall each be terminated at its designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.
 - 2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.
 - 3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
 - 4. Where standalone CAT 6A only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.
 - 5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.
 - 6. All modular jacks will be fitted with a dust cover. Modular jacks shall incorporate a dust cover that fits over and/or into the modular jack opening. The dust cover shall be designed to remain with the modular jack assembly when the modular jack is in use. No damage to the modular jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the modular jack pinning, will not be accepted.

7. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall:
 - a. Match the receptacle color used for other utilities in the building, or
 - b. When installed in surface raceway (if applicable), match the color of that raceway.
8. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:
 - a. Be a low-profile assembly.
 - b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.
 - c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.
 - d. Incorporate a shroud that protects the optical fiber couplings from impact damage.
9. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.
10. The CAT 6A modular jacks shall be non-keyed 8-pin modular jacks.
11. The interface between the modular jack and the horizontal cable shall be an angled insulation displacement type contact and shall provide separation for ANEXT suppression. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.
12. CAT 6A modular jacks shall be pinned per [TIA-568A][TIA-568B].
13. CAT 6A termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:
 - a. ANSI/TIA/EIA-568-B.2-10
 - b. IEEE 802.af (PoE)
 - c. IEEE 802.an 10GBASE-T
 - d. ISO/IEC 60603-7
 - e. ISO 11801 Class E Compliant
 - f. FCC PART 68.5 SUBPART F
14. The color for CAT 6A jacks shall be gray for wireless access point (WAP) data applications.

2.4 RG-6 BROADBAND RF COAXIAL CABLE

A. Basic Construction:

1. Center conductor: 18 AWG bare copper covered steel; 0.040" OD (nominal); foamed polyethylene dielectric.

2. Four Layer Shield:

- a. Inner shield: aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
- b. Second shield: 60% 34 AWG bare aluminum braid wire.
- c. Third shield: non-bonded aluminum foil tape.
- d. Outer shield: 40% 34 AWG bare aluminum braid wire.

B. Electrical Performance Characteristics:

1. Impedance: 75 ohms.
2. Velocity of propagation: Greater than or equal to 82%.
3. Maximum attenuation (per 100 feet) for non-plenum rated cable:
 - a. at 55-MHz: 1.60 dB
 - b. at 450-MHz: 4.26 dB
 - c. at 750-MHz: 5.59 dB
 - d. at 1000-MHz: 6.54 dB
4. Maximum attenuation (per 100 feet) for plenum-rated cable:
 - a. at 50-MHz: 1.60 dB
 - b. at 400-MHz: 4.60 dB
 - c. at 700-MHz: 6.60 dB

C. at 1000-MHz: 8.20 dB Acceptable Manufacturers:

1. Belden 1189A series
2. CommScope
3. West Penn

PART 3 - EXECUTION

3.1 CABLE INSTALLATION REQUIREMENTS

A. Horizontal Cabling:

1. The maximum horizontal cable drop length for Data UTP shall not exceed 295 feet in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing horizontal cabling in a fashion so as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Architect/Engineer prior to installation. Changes to the contract documents shall be approved by the Architect/Engineer.
2. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellum grips may be used to spread the strain over a longer length of cable.

3. Manufacturer's minimum bend radius specifications shall be observed in all instances.
 4. Horizontal cabling installed as open cabling shall be supported at a maximum of 5' between supports. Refer to the specifications for required cable supports.
 5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable ties is strictly prohibited.
 6. The maximum conduit fill for horizontal cabling shall not exceed 40% regardless of conduit length.
 7. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.
 8. Cabling shall not be routed through wall(s) without a pathway. Provide conduit sleeve pathways through wall(s) for proper installation of horizontal cabling.
- B. A coil of 3 feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook, bridle ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each horizontal cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
1. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:
 - a. Twelve (12) inches from power lines of less than 5-kVa.
 - b. Eighteen (18) inches from high-voltage lighting (including fluorescent).
 - c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
 - d. Thirty-nine (39) inches from transformers and motors.
 2. Information outlets shown on floor plans with the subscript "W" are intended to be used for wall mounted telephones. Back boxes for wall mounted telephones shall not be located within 12" vertically, or horizontally, from any light switches, power receptacles, nurse call devices, thermostats, or any other architectural element that would otherwise prevent the installation of a wall mounted telephone on the mating lugs.

3.2 CABLE TERMINATION REQUIREMENTS

A. Cable Terminations - Data UTP:

1. Modular patch panels shall be designed and installed in a fashion as to allow future horizontal cabling to be terminated on the panel without disruption to existing connections.
2. If the "last" patch (per rack) is greater than 50% utilized, one additional patch panel shall be provided for future use.

3. At information outlets and modular patch panels, the Contractor shall ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for data cables. The cable jacket shall be removed only to the extent required to make the termination.

B. Cable Terminations - RG-6 and RG-11 Coax:

1. Directional coupler / taps shall be sized to accommodate an additional 20% growth in the number of cables terminated at any given location. Unused directional coupler / tap ports shall be terminated with a 75-Ohm F-type terminator.
2. All cables shall be terminated in the specified connector type and mated directly to wall-mounted directional coupler / taps. Coaxial cables shall be dressed neatly and secured to D-rings per manufacturer guidelines.
3. When preparing the RG-6 and RG-11 coaxial cable for termination, manufacturer's installation procedures shall be adhered to. Special care shall be taken to ensure the proper center conductor length as specified by the manufacturer.
4. All coaxial cable connectors shall be mated to the cable using only the appropriate purpose-designed tools recommended by the manufacturer for that purpose.

END OF SECTION

SECTION 271710 - TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the testing requirements relating to the structured cabling system and its termination components and related subsystems.

1.2 RELATED WORK

- A. Section 270500 - Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

- A. Refer to Section 270500 for relevant standards.

1.4 SUBMITTALS

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work, the Contractor shall submit:
 - 1. Complete information on testing procedure as described herein.
 - 2. Test plan summary for each cable type to be tested including equipment to be used, setup, test frequencies or wavelengths, results format, etc.

PART 2 - PRODUCTS

2.1 TESTING COPPER

- A. General Requirements:
 - 1. Perform acceptance tests as indicated below for each sub-system (e.g., backbone, horizontal, etc.) as it is completed.
 - 2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
 - 3. Visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
 - 4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
 - 5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove the wiring connections are correct.

6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results in their native format.
7. All cabling shall be 100% fault-free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

a. CAT 3 Cable:

1) Indoor/Backbone Cable:

- a) Backbone CAT 3 copper cable shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the termination blocks (e.g., 110). Any mis-positioned pairs must be identified and corrected. The percentage of "bad" pairs shall not exceed 3% in any backbone (riser or tie) cable based on total pair count. All bad pairs must be identified and documented.

2) Horizontal Cable:

- a) Testing shall be from the modular jack at the information outlet in the work area to the 110-type termination block on which the cables are terminated at the Communication Equipment Room.
- b) Where horizontal cables are cross-connected by the Contractor to backbone cables at an intermediate or horizontal cross-connect, the Contractor will be responsible to test the entire system from each CAT 3 information outlet to the building's main cross-connect. If more than a 1% failure on the cross-connects occur, the Contractor will be required to provide mapping of the system utilizing the procedure outlined below for CAT 5E copper cabling.
- c) All horizontal cable shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.

b. CAT 6 Cable:

- 1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.

- 2) Horizontal cable shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.
- 3) CAT 6 horizontal cable shall be tested to 250 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the **"Permanent Link"**, including cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:
 - a) Wire Map
 - b) Length
 - c) NEXT Loss (Pair-to-Pair)
 - d) NEXT (Power Sum)
 - e) ELFEXT (Pair-to-Pair)
 - f) ELFEXT (Power Sum)
 - g) Return Loss
 - h) Attenuation
 - i) Propagation Delay
 - j) Delay Skew
- 4) The maximum length of horizontal cable shall not exceed 295 feet, which allows 33 feet for technology equipment and modular patch cords.
- 5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.
- 6) CAT 6 horizontal cable testing shall be performed using a test instrument designed for testing to 250 MHz or higher. Test records shall verify, "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.
- 7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

c. CAT 6A Cable:

- 1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.

- 2) Horizontal cable shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.
- 3) CAT 6A horizontal cable shall be tested to 500 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Permanent Link", including cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:
 - a) Wire Map
 - b) Length
 - c) NEXT Loss (Pair-to-Pair)
 - d) NEXT (Power Sum)
 - e) ELFEXT (Pair-to-Pair)
 - f) ELFEXT (Power Sum)
 - g) Return Loss
 - h) Attenuation
 - i) Propagation Delay
 - j) Delay Skew
- 4) The maximum length of horizontal cable shall not exceed 295 feet, which allows 33 feet for technology equipment and modular patch cords.
- 5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6A modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be used during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.
- 6) CAT 6A horizontal cable testing shall be performed using a test instrument designed for testing to 500 MHz or higher. Test records shall verify "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.
- 7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

2.2 TESTING FIBER

A. General Requirements:

1. Perform acceptance tests as indicated below for each optical fiber sub-system (e.g., backbone, horizontal, etc.) as it is completed.

2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
 3. Visually inspect all optical fiber cabling and termination points to ensure that they are complete and conform to the standards defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
 4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
 5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove that the optical fiber connections are correct.
 6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results.
 7. All optical fiber cabling shall be 100% fault-free unless noted otherwise. If any optical fiber cable is found to be outside the specification defined herein, that optical fiber cable and the associated connector(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
 8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
 9. The optical fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, provide cable manufacturer's test report for each reel of cable provided. These test reports shall include manufacturer's on-reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.
 - a. On-the-reel bandwidth performance as tested at the factory. Factory data shall be provided upon request.
 - b. The testing noted for optical fiber cabling utilizes an Optical Time Domain Reflectometer (OTDR). However, the Contractor may submit to the Architect/Engineer for pre-approval of alternate fiber optic testing equipment.
- B. Tests Prior to Installation: The Contractor, at their discretion and at no cost to the Owner, may perform an attenuation test with an OTDR at 850-nm or 1300-nm on each optical fiber of each cable reel prior to installation. Supply this test data to the Architect/Engineer prior to installation.
- C. Tests After Installation: Upon completion of cable installation and termination, the optical fiber cabling shall be tested to include:
1. Optical Attenuation ("Insertion Loss" Method):

- a. Optical Attenuation shall be measured on all terminated optical fibers in one direction of transmission using the "Insertion Loss" method measurement in accordance with the TIA/EIA 526-14, Method B, and be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made. Multimode optical fibers shall be tested at 850 ± 30 nm. Singlemode optical fibers (if applicable) shall be tested at 1300 ± 20 nm.
 - b. Attenuation of optical fibers shall not exceed the values calculated as follows:
 - 1) Attenuation (max.) = $2 * C + L * F + S$ dB.
 - 2) Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers), and F is the maximum allowable optical fiber loss (in dB/km). S is the total splice loss (# of splices * maximum attenuation per splice).
2. Verification of Link Integrity (OTDR):
- a. All optical fibers shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multimode optical fibers shall be tested at 850-nm and 1300-nm (nominal). Singlemode optical fibers (if applicable) shall be tested at 1310-nm and 1550-nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used. Access jumpers used for testing shall match the type and core diameter of the fiber optic strand under test.
 - b. Set OTDR's test variables to the manufacturer's published backscatter coefficient and velocity of propagation figure for the specific strand of fiber under test. OTDR's range should be set to approximately 1.5 times the length of the strand under test, pulse width should be optimized for the length of the fiber optic strand under test, and number of averages should be adjusted to approximately 120 seconds per wavelength.
 - c. OTDR traces revealing a point discontinuity greater than 0.2 dB in a multimode optical fiber or 0.1 dB in a singlemode optical fiber (if applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that optical fiber by the Owner. The installation of that optical fiber cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that optical fiber cable and the associated terminations shall be replaced at the expense of the Contractor.

2.3 TESTING COAX

- A. A Time Domain Reflectometer (TDR) shall be used to verify cable length and to test for cable faults and breaks. A step-function high resolution Time Domain Reflectometer shall be employed for this test. The results shall be automatically plotted on an X-Y plotter with a Y axis voltage reflection coefficient resolution of .001 per division. The X axis will resolve down to 1" of cable. The TDR will sweep the cable at a rate no greater than 50' per second, or such lower rate as necessary to resolve cable faults to the 1" and .001 VRC level.
- B. The cable shall be terminated with its characteristic impedance, and an appropriate impedance matching pad shall be used to match the analyzer to the cable where necessary. Cable shall be rejected if any single fault is observed of amplitude greater than .003 voltage reflection coefficient. Characteristic impedance shall also be measured at 5% of nominal value.
- C. Cyclic faults (such as cable reel stress and die drawdown) shall be limited to a voltage reflection coefficient of 0.005.

2.4 DOCUMENTATION/AS-BUILTS/RECORDS

- A. General:
 - 1. Upon completion of the installation, submit as-builts per the requirements of Section 270500 and Division 1. Documentation shall include the items detailed in the subsections below.
 - 2. All documentation, including hard copy and electronic forms, shall become the property of the Owner.
 - 3. The Architect/Engineer may request that a 10% random field retest be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Architect/Engineer, including a 100% retest. This retest shall be at no additional cost to the Owner.
- B. Copper Media Test Data:
 - 1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
 - 2. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package. The Contractor shall furnish this information in electronic form (USB thumb drive). The thumb drive shall contain the electronic equivalent of the test results as defined by the bid specification and be in the tester's native format as well as summaries of each test in pdf format. Provide a licensed copy of the software required to view and print the data that is provided in a proprietary format. Furnish one (1) copy of the data and display (if applicable) software.

C. Optical Fiber Media Test Data:

1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. OTDR traces of individual optical fiber "signatures" obtained as specified above shall be provided to the Architect/Engineer in electronic form for review. Trace files shall be so named as to identify each individual optical fiber by location in the cable system and optical fiber number or color. Where traces are provided in electronic form, provide along with the above documentation, one (1) licensed copy of software that will allow for the display of OTDR traces provided. The software shall run on a Microsoft Windows-based personal computer.

D. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 280500 - BASIC ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Safety and Security System Requirements (herein referred to Security) specifically applicable to Division 28 sections, in addition to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

- A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the security systems as shown on the drawings and specified herein.
- B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make the portion of the security systems a finished and working system.
- C. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the Construction Manager's scope statements for complete scope of work description.
- D. Description of systems include but are not limited to the following:
 - 1. Electronic access control system
 - 2. Video surveillance, cabling by contractor, cameras and programming by owner.
 - 3. Fire detection and alarm.
 - 4. Low voltage security wiring (less than +120VAC) as specified and required for proper system control and communications.
 - 5. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
 - 6. Firestopping of penetrations of fire-rated construction as described in Section 270503.

1.3 OWNER FURNISHED PRODUCTS

- A. Cameras and programming. Recording devices are existing to remain.

1.4 WORK SEQUENCE

- A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.

1.5 DIVISION OF WORK BETWEEN ELECTRICAL AND SECURITY CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

- B. Definitions:

- 1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
 - 2. "Electrical Contractor" shall also refer to the Contractor listed in Division 28 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
 - 3. "Security Contractor" as referred to herein refers to the Contractors listed in Division 28 of this Specification.
 - 4. Low Voltage Security Wiring: The wiring (less than 120VAC) associated with the Security Systems, used for analog and/or digital signals between equipment.

- C. General:

- 1. The purpose of these Specifications is to outline typical Electrical and Security Contractor's work responsibilities as related to security systems including back boxes, conduit, power wiring and low voltage security wiring. The prime contractor is responsible for all divisions of work.
 - 2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Security Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Security Drawings but required for the successful operation of the systems shall be the responsibility of the Security Contractor and included in the Contractor's bid.
 - 3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Security systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Security Contractor has convened to determine the exact location and requirements of the installation.
 - 4. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Security Wiring, the installation shall not begin until the Security Contractor has completed a coordination review of the cable tray shop drawing.

5. This Contractor shall establish Electrical and Security utility elevations prior to fabrication and installation. The Security Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:

- a. Lighting Fixtures
- b. Gravity Flow Piping, including Steam and Condensate
- c. Sheet Metal
- d. Electrical Busduct
- e. Cable Trays, including 12" access space
- f. Sprinkler Piping and other Piping
- g. Conduit and Wireway
- h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Assumes all responsibility for providing and installing cable tray.
3. Responsible for Security Systems grounding and bonding.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Security Contractor's Responsibility:

1. Assumes all responsibility for the low voltage security wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of security equipment which is required to be bonded to the telecommunications bonding system.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.

- a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
 - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
 3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect/Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Architect/Engineer and Owner's Representative. The Architect/Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The Architect/Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect/Engineer.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the Architect/Engineer at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect/Engineer and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
2. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the installation, termination, testing, and placing into operation electronic security devices shall be individually trained by the manufacturer.
3. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
4. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of electronic security devices and have personnel adequately trained in the use of such tools and equipment.
5. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
 - a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
6. Conform to all requirements of the City of Rogers, Arkansas Codes, Laws, Ordinances and other regulations having jurisdiction.

7. Conform to all published standards of Mercy Health Contractor Guidelines for MTS Low Voltage Structured Cabling (latest publication).
8. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
9. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
10. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
11. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
12. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

B. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. All equipment, and materials shall be as approved or listed by the following:
(Unless approval or listing is not applicable to an item by all acceptable manufacturers.)
 - a. Factory Mutual
 - b. Underwriters' Laboratories, Inc.

C. Examination of Drawings:

1. The drawings for the Security Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.

3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

D. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
4. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
5. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
6. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
7. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

E. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.8 WEB-BASED PROJECT SOFTWARE

- A. The General Contractor shall provide a web-based project software site for the purpose of hosting and managing project communication and documentation until completion of the warranty phase.

- B. The web-based project software shall include, at a minimum, the following features: construction schedule, submittals, RFIs, ASIs, construction change directives, change orders, drawing management, specification management, payment applications, contract modifications, meeting minutes, construction progress photos.
- C. Provide web-based project software user licenses for use by the Architect/Engineer. Access will be provided from the start of the project through the completion of the warranty phase.
- D. At project completion, provide digital archive of entire project in format that is readable by common desktop software applications in format acceptable to Architect/Engineer. Provide data in locked format to prevent further changes.

1.9 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item	Coordination Drawings
28 13 00	Electronic Access Control	

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

- a. Date
- b. Project title and number
- c. Contractor's name and address
- d. Division of work (e.g., plumbing, heating, ventilating, etc.)
- e. Description of items submitted and relevant specification number
- f. Notations of deviations from the contract documents
- g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

- a. Date
- b. Project title and number
- c. Architect/Engineer
- d. Contractor and subcontractors' names and addresses
- e. Supplier and manufacturer's names and addresses
- f. Division of work (e.g., plumbing, heating, ventilating, etc.)
- g. Description of item submitted (using project nomenclature) and relevant specification number
- h. Notations of deviations from the contract documents
- i. Other pertinent data
- j. Provide space for Contractor's review stamps

3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
- b. The Contractor shall clearly indicate the size, finish, material, etc.
- c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
- d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 28 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 28 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
- B. Store materials on the site to prevent damage.
- C. Keep fixtures, equipment and materials clean, dry and free from harmful conditions.

1.11 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.12 WARRANTY

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 28 may require additional warranty requirements for specific equipment or systems.
- B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.
- C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.13 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.14 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers' equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.
- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

- 2.1 Refer to individual sections.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 260533. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.
- C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.
- D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

A. General:

1. Refer to specific Division 28 sections for further requirements.
2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.

2. Refer to the end of Section 270500 for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.

C. Before final payment will be authorized, this Contractor must have completed the following:

1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
2. Submitted bound copies of approved shop drawings.
3. Record documents including edited drawings and specifications accurately reflecting field conditions, inclusive of all project revisions, change orders, and modifications.
4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
5. Submitted testing reports for all systems requiring final testing as described herein.
6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; submit receipt to Architect/Engineer prior to final payment being approved.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div28.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div28.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.
- F. Refer to the individual specification sections for minimum hours of instruction time for each system.
- G. Operating Instructions:
 - 1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the security systems.
 - 2. If the Contractor does not have Engineers and/or Technicians on staff that can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM STARTING AND ADJUSTING

- A. The security systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.
- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- C. This Contractor shall maintain at the job site, a separate and complete set of Security Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record actual routing of all conduits sized 2" or larger.
- E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

To assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

1. All cabling pathways (cable tray, ladder rack, conduit sleeves, etc.) are installed and all cabling has been pulled through them.
2. All mechanical firestop products are installed and all other penetrations have been sealed.
3. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.
4. All access control system equipment, including card readers, conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational.

Prime Contractor: _____ By: _____

Requested Observation Date _____ Today's Date: _____

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

END OF SECTION

SECTION 281300 - ELECTRONIC ACCESS CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Field Control Hardware
- B. Portal Devices

1.2 RELATED WORK

- A. Section 087100 - Door Hardware
- B. Section 260513 - Wire and Cable
- C. Section 260533 - Conduits and Boxes
- D. Section 260535 - Surface Raceways
- E. Section 270526 - Communications Bonding
- F. Section 270528 - Interior Communication Pathways
- G. Section 270553 - Identification and Administration
- H. Section 271500 - Horizontal Cabling Requirements
- I. Section 280500 - Basic Electronic Safety and Security System Requirements.
- J. Section 283100 - Fire Detection and Alarm Systems.

1.3 QUALITY ASSURANCE

- A. Manufacturer: The manufacturer shall have a minimum of ten (10) years documented experience in the development and manufacture of access control software and hardware. The software developer shall be, at a minimum, a Microsoft Silver Certified Integrator and Partner for those systems that reside in a Microsoft environment.
- B. Contractor:
 - 1. Shall be a factory-authorized installation, service and support company specializing in the selected manufacturer's product, with demonstrated prior experience of a minimum of three (3) years installing, programming and supporting the selected manufacturer's system.
 - 2. Shall have been in business for a minimum of three (3) years and shall have installed a minimum of three (3) similar or larger sized systems. Contractor shall have a minimum of two (2) service technicians who are certified in the proposed manufacturer's system.

3. Shall have as a regular, full time employee retain the services of a minimum of one employee with the following certification(s) or education Should more than one certification be required, one employee may maintain multiple certifications.
 - a. A certification of RCDD from BICSI or CNIDP from CNet.
 - b. A certification of MCSA: Server: Server Infrastructure from Microsoft.
 - c. A certification of CCNA or CCNP from CISCO.

C. Material:

1. All material which is Contractor furnished shall be new, unused and free from defects.
2. Where more than one of any specified item of equipment or material is used, all such items shall be the same product from the same manufacturer.

1.4 REFERENCES

- A. International Building Code
- B. NFPA 70 - National Electrical Code.
- C. The BOCA National Building Code
- D. UL 294 - Standard for Access Control Systems.
- E. UL 365 - Standard for Police Station Connected Burglar Alarm Units and Systems.
- F. UL 464 - Standard for Audible Signal Appliances.
- G. UL 603 - Standard for Power Supplies for Use with Burglar Alarm Systems.
- H. UL 609 - Standard for Local Burglar Alarm Units and Systems
- I. UL 634 - Standard for Connectors and Switches for Use with Burglar Alarm Systems.
- J. UL 827 - Standard for Central Station Alarm Services.
- K. UL 1076 - Standard for Proprietary Burglar Alarm Units and Systems.
- L. UL 1449 - Standard for Surge Protective Devices.
- M. UL 1635 - Standard for Digital Alarm Communicator Systems.
- N. UL 1638 - Standard for Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling.
- O. UL 1778 - Uninterruptible Power Systems.

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 280500.

- B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item.
 2. All component options and accessories specific to this project.
 3. Electrical power consumption rating and voltage.
 4. Heat generation for all power consuming devices.
 5. Wiring requirements.
 6. Server processor(s), workstation configurations, total and available disk space, and memory size.
 7. All network bandwidth, latency and reliability requirements.
 8. Backup/archive system size and configuration.
 9. Submit two of each type of credential to be used (access card, key fob, etc.).
- C. System Drawings: Project-specific system CAD drawings shall be provided as follows:
1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where each controller will be located. This block diagram shall be provided in Adobe PDF.
 2. Provide a schedule of all controllers and the doors/points each controller controls. This schedule shall be provided in Adobe PDF.
 3. Provide schedules describing each system input location by an architecturally familiar reference, e.g., Door 312A. The architectural door schedule shall be used as the basis. These schedules shall be provided in Adobe PDF.
- D. Submit sample format of site specific programming guides to be used for system planning/programming conference with Owner. These guides shall be provided in Adobe PDF.
- E. So that required Owner personnel are present at the planning/programming conference required in Part 3 of this section, submit meeting agenda for the conference a minimum of two weeks prior to the conference.
- F. Submit detailed description of Owner training to be conducted at project end, including specific training times. Refer to Part 3 of this section for details.
- G. IP Addresses: Contractor shall provide to Owner, in a documented transmittal and in Microsoft Excel format, the names and locations of devices which require an IP address. An authorized representative of the Owner shall furnish the addresses for the associated devices in Microsoft Excel format in a documented transmittal. Should Owner change the IP address structure after approval of the list, Owner may be responsible for additional fees involved with reprogramming.

1.6 SYSTEM DESCRIPTION

- A. This section describes the furnishing, installation, programming and commissioning of additions to the existing access control system. The terms "access control system" and "security management system", or SMS, may be used interchangeably herein.
- B. The company, manufacturer, and product names used in this section are for identification purposes only. All trademarks and registered trademarks are the property of their respective owners.
- C. Performance Statement: This section and the accompanying access control-specific design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming, and miscellaneous equipment required. The Contractor shall be responsible for determining quantities of materials required for a complete and operational system. Floor plan drawings and schedules have been developed to aid the Contractor in determining device quantities and installation locations, but, where discrepancies between floor plans and schedules arise, the greater number shall govern.
- D. Basic System Description:
 - 1. The access control system shall provide the following functionality:
 - a. Electronic control access to designated areas.
 - b. Validation of cardholder credentials by use of personnel database, card formats, PINs. The system shall compare the time, location, and unique credentials of an attempted entry with information stored in the database.
 - c. Access to designated areas will be validated only when a user's credential has a valid number for its facility and the number is valid for the current time and for the reader where it is used.
 - d. The system software shall access the hardware that validates the person and monitors the security of a building by use of intelligent system controllers, reader interfaces, locks, readers, inputs and outputs. When access has been validated, a signal to the portal locking device shall be activated to enable alarm free access at that location.
 - e. The system shall be configured by use of application software.
 - f. The system shall monitor activities using operator monitoring software which includes graphical maps which display alarms, status and activity.
 - g. The system shall differentiate and restrict administrative and operational access through use of password authentication.
 - h. The system shall report on various aspects of the system by use of reports, both default and customizable. Reports shall be able to be printed.
 - i. The system shall have the capability to report alarms both audibly and visually.
 - j. The system shall control hardware from the monitoring station by use of manual actions and events.

- k. The system shall provide record and data management by use of journals. There shall be a full audit trail.
 - l. The system shall allow for data to be imported from other products by use of database migration tools. These products may include Human Resources databases for name and/or time and attendance information, information from previous access control systems consisting of badge numbers from credentials that will be re-used, Microsoft Excel spreadsheets, or other systems as defined herein.
 - m. The system shall allow access using a web interface or a mobile application for use on the iOS and Android operating systems.
 - n. The system shall utilize Open Supervised Device Protocol (OSDP) version 2.0 or later to all peripheral devices.
 - E. Integrations, Software Development Kit (SDK) and Application Programming Interface (API):
 - 1. The manufacturers of the systems that are integrated shall make an SDK available to other manufacturers.
 - 2. Prior to the release of this section, the manufacturers of the systems that are to be integrated shall have made available to each other all APIs to perform the specific integrated functions required in this section.
 - 3. The integrations shall be completed and tested, and shall have been implemented on at least one system of similar size prior to the release of this section. The integrations shall not be accomplished for the first time for this project unless written pre-approval has been granted by Owner to Contractor prior to bid deadline.
 - 4. During the warranty period, should a new API or version of software be released by the SMS manufacturer or any of the manufacturers of systems or devices that are integrated, that API or version of software shall be installed in the appropriate system or device defined in this section at no charge to Owner. Should any loss of functionality in the integration be exposed through this installation, as compared to the accepted system, Contractor shall correct the functionality at no charge to Owner.
 - 5. Any and all development costs for specified functionality or inter-system integrations shall be included in the Contractor's bid. No additional costs or fees for the integrations shall be charged to Owner from the time of notice to proceed through system acceptance.
- 1.7 OWNER FURNISHED MATERIAL
- A. Telephone service
 - B. Data circuit / internet service
 - C. Active telephone service equipment, such as key system, PBX or VOIP switch equipment
 - D. Active computer network equipment:
 - 1. Routers
 - 2. Switches

3. Hubs
4. Wireless access points
5. Uninterruptible power supplies for Owner furnished products

E. Active computer equipment:

1. SMS server - refer to Part 2 for details
2. SMS workstation(s) - refer to Part 2 for details
3. SMS badging station(s) - refer to Part 2 for details
4. Uninterruptible power supplies for Owner furnished products

F. Credentials:

1. Badges
2. Key fobs
3. Adhesive tags
4. Active transmitters

1.8 LICENSING REQUIREMENTS

A. All user licenses required for system operation shall be included in the Contractor's bid. User licenses shall include server and workstation software, network controllers, card readers, printers, badging stations, and any other licensing that is required by the manufacturer for operation of any system component.

1. Licenses shall be provided on a one-to-one basis. One license shall be provided for each device requiring a license. In the event the manufacturer requires the purchase of a block of licenses, license blocks provided shall be no greater than what is required for the number of devices in this project. Contractor shall document the number of remaining licenses in the project record documents and Operations and Maintenance data.
2. The system described herein is an extension of an existing Lenel On-Guard system. All licensing shall be new for each installed device. The Contractor shall not use any of the Owner's existing (spare) licenses for any new components.
3. All Contractor-furnished software shall contain a perpetual, permanent license in which no other fees beyond the single payment for the work of this section are required in order to use the proposed software indefinitely. Owner understands that, after the initial warranty period has expired, maintenance and technical support fees may be required annually, quarterly, or monthly in order to receive software updates and technical support. However, it remains the option of Owner to purchase or decline this service. If Owner chooses to discontinue or never purchase this service, the software shall continue to be legally licensed for use. All software shall be the latest version released, and all Contractor-furnished servers and workstations shall be current on all patches and updates for all software on the machines at the time of acceptance of the associated systems.
4. The SMS shall require only a single license key present on the server for the SMS to operate. The key shall be a physical device or a software key. License keys shall not be required at the client workstations.

1.9 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 280500.
- B. Provide final system block diagram showing any deviations from shop drawing submittal.
- C. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.
- D. Provide schedules documenting:
 - 1. Controller installation locations including specific door numbers being controlled.
 - 2. All terminal block wiring, including cable numbers.
- E. Warranty: Submit written warranty and complete all Owner registration forms.
- F. Complete all operation and maintenance data manuals as described below.

1.10 OPERATION AND MAINTENANCE DATA

- A. Submit documents under the provisions of Section 280500.
- B. Manuals: Final copies of the manuals shall be delivered within 14 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system, and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. Manuals shall be submitted in both hardcopy and electronic format. The manuals shall consist of the following:
 - 1. Hardware Manual: The manual shall describe all equipment furnished including:
 - a. General description and specifications.
 - b. Installation and check out procedures.
 - c. System and equipment layout and electrical schematics to the control board and field device level. For multiple devices wired identically, only one wiring diagram is required per door configuration, to be labeled "TYPICAL".
 - d. Alignment and calibration procedures.
 - e. Manufacturers repair parts list indicating sources of supply.
 - 2. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, cleaning, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.11 WARRANTY

- A. Unless otherwise noted, provide warranty for one (1) year after date of Substantial Completion for all materials and labor.
- B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.
 - 1. Inspections: The Contractor shall perform two minor inspections at six-month intervals (or more often if required by the manufacturer), and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
 - 2. Minor Inspections: These inspections shall include:
 - a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
 - b. Mechanical adjustments if required on any mechanical or electromechanical devices.
 - 3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:
 - a. Clean all equipment, including exterior surfaces and accessible and serviceable interior surfaces.
 - b. Perform diagnostics on all equipment.
 - c. Check, test, and calibrate (if required) all sensors.
 - d. Run all system software diagnostics and correct all diagnosed problems.
- C. Operation: Upon the completion of any scheduled adjustments or repairs, Contractor shall verify operation of the SMS.
- D. Service: The Owner will initiate service calls when the SMS is not functioning properly. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Qualified service personnel shall be at the site within 24 hours after receiving a request for service.

- E. Records, Logs and Work Requests: Contractor shall keep records and logs of each task completed under and outside of warranty. These logs shall be maintained in Microsoft Word or Excel. The log shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, description of work performed, the amount and nature of the material used, and the time and date of commencement and completion of the work. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the SMS. The Contractor shall deliver a record of the work performed within three (3) business days after work is completed. Defective items that have been replaced shall be given to the Owner. Should the replacement item be a temporary replacement until the removed item is repaired, Contractor shall retain possession of the defective item for repair and subsequent re-installation.
- F. System Modifications: Modifications by the Contractor are allowed after system acceptance. Contractor shall make recommendations for system modification in writing to the Owner. No system modifications shall be made without prior, written approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Manuals, and other documentation affected. The Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.
- G. Software: At no charge, the Contractor shall provide to Owner all updates released by the manufacturer during the period of the warranty and verify operation of the system upon installation. These updates include system software updates, patches, bug fixes and revisions, as well as firmware updates. These updates shall be accomplished in a timely manner, fully coordinated with SMS administrators and operators, shall include training for the new changes/features, and shall be incorporated into the Operations and Maintenance Manuals and software documentation.
- H. Refer to the individual product sections for further warranty requirements of individual system components.

PART 2 - PRODUCTS

2.1 ELECTRONIC ACCESS CONTROL SYSTEM MANUFACTURERS

- A. LenelS2 OnGuard
- B. Should the access control manufacturer offer, as an option, the use of hardware by Mercury Security, the Contractor proposed solution shall utilize this hardware. Contractor shall state whether or not the software is compatible with the SCP, AP and EP families of Mercury Security hardware. For future additions or defective hardware replacements, the system shall not be "locked" to require Mercury Security hardware be purchased only from the access control software manufacturer or from the original Installing Contractor.

C. Approval of Alternate Manufacturers:

1. Contractors seeking approval for alternate manufacturers for any devices or software in this section shall submit requests for approved equals as defined by Division 1 in addition to submitting:
 - a. Bill of materials for each piece of hardware and software proposed.
 - b. Manufacturer's data sheet for each piece of equipment proposed.
 - c. Line-by-line typewritten statement of compliance or non-compliance comparing Part 2 of this section with the published specifications of the proposed alternate products. This compliance statement shall be signed by an officer of the local contractor branch office that proposes to install the alternate product and either an officer of the manufacturer or an officer of the manufacturer's representative.
2. Refer to the project drawings for manufacturer and model numbers for the Basis of Design products.

2.2 FIELD CONTROL HARDWARE

A. Interior Control Panels:

1. Control boards, power distribution and terminals shall be enclosed in a NEMA 1 rated enclosure that is key lockable. Contractor shall not furnish padlock. All enclosures that are part of this project shall be keyed alike. Contractor shall furnish and install a mechanically fastened tamper switch on the interior of the enclosure.
2. Control boards are allowed to be in an enclosure separate from the power supplies/power distribution. Should they be in separate enclosures, the interface wiring shall be in rigid metallic conduit, RMC, with Myers hubs at both ends of the conduit.
3. Control panels shall be rack mountable in an enclosure specifically for rack mounting. Control boards and power supplies shall be located in the enclosure. The enclosure shall have screw or compression terminals on the rear panel for connection of field devices.
4. Intra-enclosure wiring shall be dressed using tie wraps and/or covered plastic wire way. Hook-up wires for identical purposes shall have the same color insulation. For example, if one input pair utilizes green and white insulated conductors, all similar inputs shall use green and white insulated conductors. The same color scheme shall be followed for all access control panels that are part of this project.
5. Cabling from field devices such as readers, door position switches, request-to-exit devices and locking devices shall not be directly terminated to the control boards and power supplies. The field devices shall be terminated to terminals located on the left side, right side or both sides of the enclosure back panel. Intra-enclosure wiring shall be routed from the terminals to the control boards and power distribution. Quantity and functional sequence of the terminals shall be identical portal to portal.

6. All devices inside the enclosure, less cabling and batteries, shall be mechanically fastened to a removable solid or perforated metal back panel with either:
 - a. Metal or plastic standoffs
 - b. DIN rail
7. Hook and loop fasteners, double sided tape or adhesives are not allowed to attach devices to the back panel. Mounting devices to the interior of the door shall only be allowed when the following two (2) conditions are met:
 - a. The access control hardware manufacturer offers prefabricated enclosures with devices mounted to the interior of the door.
 - b. Only the same devices that the access control manufacturer mounts to the interior of the door are allowed to be mounted in a different enclosure, and those devices shall be mounted in an identical manner.
8. 120V 20A input power shall be hard wired to a circuit breaker disconnect and to one duplex receptacle on the interior of the enclosure. Should devices in the enclosures require plug-in transformers/power supplies, the receptacle shall be utilized. One (1) power strip with integrated circuit breaker shall be located in the bottom of the enclosure as needed.
9. Power to the locking devices shall be provided by a power distribution board with no fewer than four (4) outputs. Each lock shall be individually protected. The power distribution board shall:
 - a. Provide protection with fuses or positive temperature coefficient (PTC) devices.
 - b. Provide control so that each output is individually selectable as latching or non-latching with fire alarm activation.
 - c. Provide control so that each output shall have Fail Safe and Fail Secure terminals.
 - d. Provide a fire alarm input with associated trigger LED.
 - e. Provide an individual LED per output to indicate when an input has been triggered and the associated output has been activated.
 - f. Accept a dry, closed contact input to activate the individual lock outputs.
 - g. Provide a dry, Form C relay that energizes on activation of the fire alarm input. This output may then be used as a fire alarm input to other power distribution boards in the same or a different enclosure, or may provide input to another device such as a multi-pole relay.
10. A minimum of four (4) 12V 7 AH rechargeable, sealed, lead acid batteries shall be located in the bottom of the enclosure. Two of the batteries shall be connected in series for 24V devices, and two batteries shall be connected in parallel for 12V devices. Connections to the batteries shall be made with appropriate terminals crimped on the connecting conductors. Batteries shall be clearly labeled in a permanent manner with the date of installation.

11. Power to control boards, readers and auxiliary devices such as request-to-exit motion detectors shall be provided by a power distribution board with no fewer than four (4) outputs. All devices powered by the same voltage at an individual portal shall be protected by the same fuse or PTC unless current requirements dictate otherwise. Individual fuses or PTCs may protect more than one control board.
12. All access control panels, when populated with control boards and power supplies, shall have the following capacities:
 - a. Control of a minimum of two (2) portals.
 - b. Spare capacity of a minimum of one (1) access control portal, two (2) auxiliary inputs and two (2) auxiliary outputs greater than the requirements of the project at the time of system specification.
 - c. Five (5) spare fuses of each type used, to be in their original packaging, to be located in each power supply enclosure.
 - d. 50% spare current capacity on all power supplies located in unconditioned spaces and 40% spare capacity for those in conditioned spaces. Lower spare capacities are allowable based on prior approval of Contractor-provided power calculations.
13. Locations where enclosures may be mounted are shown on the plans. Final location, with approval of Owner's representative, shall be selected by Contractor based on distribution of controlled portals and devices.
14. At time of Substantial Completion, Contractor shall furnish a schematic diagram of intra-enclosure wiring and a complete bill of materials for the enclosures and the devices located within. This documentation shall include a schedule of fuses and the device(s) that each fuse protects. This documentation shall be placed by Contractor in a Contractor-furnished print pocket located on the inside of the enclosure door.

B. Intelligent System Controllers (ISC):

1. The controller shall communicate with the host via an on board 10/100/1000 Base T Ethernet port.
2. The controllers shall be a distributed architecture with full peer-to-peer networking capability. Parent/Child controller configurations are not acceptable. All controllers in the system shall be capable of operating in a standalone mode if communication is lost with the server or main controller. In no case shall a controller depend on communication with an upstream controller for proper standalone operation.
3. The communications bus shall be supervised for wiring integrity. If a communication failure is detected, the system shall report the loss. All controllers unable to receive communication shall operate as standalone devices including grant/deny decisions, complete with event buffers. All events shall be uploaded to the server upon restoration of communications.
4. Controllers shall be AES 128-bit symmetrical block encryption devices conforming to FIPS-197.
5. Controllers shall support a minimum of SHA-2 authentication security.
6. The controllers shall utilize flash memory or similar technology, allowing program updates to be downloaded from the server. Program storage shall be in ROM.

7. The controllers shall have the capacity for 15,000 cardholders and 45,000 transactions. All access decisions involving these cardholders shall be made at the lowest controller level without communication to the server.
8. Handle all non-host related access control monitoring and decision making.
9. LED indicators for power, fault and communications.
10. Provide for local and global input/output linking:
 - a. The SMS shall support a global linkage feature whereby any input/output/event shall be linked to any other input/output/event in the SMS. Input/output linkages shall be able to span across intelligent system controllers.
 - b. System administrators shall be able to create global input/output function lists, each consisting of a sequence of actions to be performed, such as changing card reader modes, activating outputs, and opening or closing anti-pass back areas. Each function list may include up to six actions.
11. Reporting of transactions and status information to the server.
12. Interface with standard reader technologies without special interface hardware, additional logic panels or other integrators. Supported technologies shall include:
 - a. 13.56 MHz Contactless Smart with or without biometrics or keypad
 - b. 13.56 MHz Multi-technology Smart
 - c. Proximity, with or without keypad
 - d. Magnetic stripe, with or without keypad
 - e. Wiegand
 - f. QR Code/Bar code
 - g. Keypad
 - h. Biometric, with Wiegand output
 - i. OSDP

C. Reader Interface Module (RIM):

1. Reader interface modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of reader interface modules required based on the inherent characteristics of each product line and the requirements and restrictions described in this document.
2. RIM shall interface with and accept data from TTL, Wiegand and RS-485 type readers and door hardware.
3. RIM shall provide a minimum of three (3) inputs per portal for portal position, request to exit and auxiliary input.
4. RIM shall provide a minimum of two (2) outputs per portal for locking device and auxiliary output. Each output shall be Form C and shall be rated at 3A at 28VDC.
5. RIM shall communicate to controller by RS-485.

D. Input Control Module (ICM):

1. The input control module shall provide supervised and non-supervised alarm input zones and monitor/report line fault conditions, alarm conditions, power faults and tampers.

2. Input control modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of input control modules required, based on the inherent characteristics of each product line and the requirements and restrictions described in this document.
3. UL 294 and 1076 listed.
4. Each input configurable for normally open or normally closed.
5. Each input configurable for timing.
6. Each input configurable for end of line resistance.
7. Status LEDs for communication to the host, heartbeat and input status.
8. Communications line supervision.
9. AES 128 bit encryption.
10. 2-wire RS485 communications.
11. No fewer than eight (8) inputs per board/control module.
12. Alarm Masking: The ability to mask the alarm input on a time zone basis.
13. Activate Output: The ability for any input to activate any output.
14. Configuration of Debounce Time: The ability to control the amount of time that an input state change must remain consistent in order for it to be considered a real change of state.
15. Elevator control support for number of floors shown on the drawings.
16. Global Linkage: The ability to link outputs with inputs that are attached to any ICM/output control module (OCM).
17. Checkpoint: The ability to configure an input as a designated stop on one or more guard tours.
18. Entry/Exit Delay: The ability to set up entry/exit delays for inputs that are attached to any ICM. This shall include:
 - a. Non-Latched Entry: When an input activates, the alarm will not be reported until the entry delay expires. If the input is still active when the entry delay expires, the alarm will be reported. If the input is not active when the entry delay expires, then the alarm will not report.
 - b. Latched Entry: When an input activates, the alarm will not be reported until the entry delay expires. If the input is still active when the entry delay expires and the alarm has not been masked, the alarm will be reported. If the input has been masked when the entry delay expires, then the alarm will not report.
 - c. Exit Delay: When an input activates, the alarm will not be reported (operates as if masked) until the exit delay expires. If the input is still active when the exit delay expires, the alarm will be reported. If the input is not active when the exit delay expires, the alarm will not be reported.

E. Output Control Module (OCM) and Functionality:

1. Output control modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of output control modules required, based on the inherent characteristics of each product line and the requirements and restrictions described in this document.
2. The output control module(s) shall provide Form C relay contacts for load switching, rated at 3A at 28VDC.
3. Each relay shall support "On" "Off" and "Pulse."

4. Outputs can be pulsed from 0.1 seconds to 24 hours.
5. Status LEDs for communication to the host, heartbeat and relay status.
6. 2-wire RS485 communications.
7. No fewer than eight (8) outputs per board/control module.
8. Communications line supervision.

2.3 PORTAL DEVICES

A. Credential Readers:

1. Manufacturers:
 - a. HID Multiclass SE
2. Multi-Technology:
 - a. Compatible with 125 kHz proximity, 13.56 MHz Contactless Smart card, MIFARE, DESFire EV1.
 - b. Backwards compatibility with legacy 13.56 MHz Contactless Smart cards and 125 kHz proximity access control formats, including 26, 32, 35, 37 bit as well as HID Corporate 1000 format.
3. Card readers manufactured specifically for non-access control applications shall not be acceptable.
4. FIPS 201 compliant.
5. Provide compatibility with most access control systems by providing card data outputs in Wiegand.
6. Compatible with OSDP access control systems.
7. Allow the firmware to be updated in the field without the need to remove the reader from the wall.
8. Secure mounting methods using tamper resistant screws.
9. An audio beeper that provides various tones to signify access granted, access denied, power up and diagnostics.
10. Tri-color LED or three (3) LEDs for visual notification of various conditions.
11. ISO1443A, 1443B and 15693 compliant.
12. The ability to transmit an alarm from an integrated tamper switch.
13. Support dual authentication of identity through the combined use of access badge and personal identification number (PIN) on an integrated 12 key keypad.
14. PBT polymer or UL94 polycarbonate.
15. Read Range:
 - a. Using 125 kHz cards or 13.56 MHz Contactless Smart cards, minimum operational read range shall not be less than one (1) inch after the readers have been installed in their permanent locations.
16. Operational voltage of 5-16 VDC, with operating temperature range of -31° F to 150° F, and rated for outdoor use with a minimum rating of IP55.
17. Readers and credentials shall be compatible with each other and shall be from the same manufacturer.

18. Available in sizes to be mounted to a standard single gang box or to a mullion.
Maximum sizes:
 - a. Single gang box mount, with or without keypad: 5.1" x 3.1" x 1.1"
 - b. Mullion mount: 6.0" x 1.9" x 0.9"
 19. Lifetime warranty against defects in material and workmanship.
- B. Request-To-Exit Motion Detector:
1. Manufacturers:
 - a. Bosch DS 160 Series
 2. Door monitor with sounder alert. Sounder alert shall have adjustable volume.
 3. Adjustable latch time.
 4. Selectable fail safe/fail secure.
 5. Activation LED.
 6. 12 or 24 VDC operation.
 7. Sequential logic input.
 8. Two (2) Form C contacts.
 9. Tamper switch.
 10. Field of view masking.
- C. Door Position Switch:
1. Manufacturers:
 - a. GE
 - b. GRI
 - c. Honeywell
- D. Duress Buttons:
1. Manufacturers:
 - a. Honeywell (Hardwired) 269R, 270R
 - b. United Security Products (Hardwired) HUB Series
 - c. Inovonics (Wireless) EN4216/32 MR Series
 - d. Linear (Wireless) DXSR-1508
 - e. Honeywell (Wireless) 5800 Series
 - f. Pre-approved equal
 - g. Refer to drawings for approved manufacturers.
 2. Multi technology:
 - a. Hardwired:
 - 1) DPDT contacts
 - 2) Silent operation
 - 3) Recessed activation button to prevent accidental activation.

- 4) Screw terminal connections
- 5) Key switch resettable
- 6) [Momentary][Latching] contacts

b. Wireless:

- 1) Transmitter supervision with minimum SPST relay outputs or communication with compatible control panel
- 2) Available repeaters for increased range or alternate long range model from the same manufacturer
- 3) Minimum 300 MHz operation
- 4) Outputs activated per transmitter
- 5) Transmitters: <Insert>

E. Cable:

1. Composite cable is allowed, although sufficient conductors may not be available in composite cables for all portal configurations. Contractor shall be responsible for additional required cables beyond one composite cable to each portal to meet functional requirements of the system.
 - a. Weigand Reader: 18 AWG, 3 pair, stranded, overall shield. Shield shall be grounded at control panel end only.
 - b. Request to Exit Motion Detector: 22 AWG, 4 conductor, stranded.
 - c. Door Position Switch: 22 AWG, 2 conductor, stranded.
 - d. Request to Exit Button: 22 AWG, 4 conductor, stranded.
 - e. Lock: Minimum 18 AWG, 4 conductor, stranded.
 - 1) Lock may require heavier gauge cable depending on door hardware solution power requirements. Contractor shall coordinate with door hardware provider for higher current devices and shall adjust the gauge of the lock cable accordingly.
 - f. Auxiliary Devices: Refer to plans for requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with the manufacturer's instructions and recommendations for installation of all products.
- B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.
- C. Network controllers shall be installed centralized in the nearest telecommunications room(s). Mount controllers to the structural walls in a location coordinated with other utilities. Coordinate exact location with Owner prior to installation. Provide dedicated +120 VAC emergency power circuit to the controllers using #12 AWG wiring from the nearest emergency electrical power distribution panel board.

- D. Provide wiring and connection to all electrified locking hardware devices. Complete programming and testing of all electrified locking hardware devices.
- E. Install all credential readers in accordance with manufacturer's instructions where shown on floor plans, in accordance with the Americans with Disabilities Act (ADA) requirements. Provide wiring and connection to all credential readers. Complete programming, adjustment, and testing of all credential readers.
- F. Provide wiring and connection to all hardware request-to-exit devices that are integral to electrified door hardware. Provide wiring and connection to all request-to-exit motion detectors. Complete programming and testing of all integrated request-to-exit devices. Where possible, avoid false activation by persons passing by but not exiting.
- G. Install all request-to-exit motion detectors in accordance with manufacturer's instructions directly above the door frame, centered on the door opening. Adjust sensitivity to permit operation on motion of persons within 2'-0" of door. Avoid false activation by persons passing by where possible.
- H. Install all request-to-exit pushbuttons in accordance with manufacturer's instructions where shown on floor plans, in accordance with the Americans with Disabilities Act (ADA) requirements. Provide wiring and connection to all request-to-exit pushbuttons. Complete programming, adjustment and testing of all request-to-exit pushbuttons.
- I. Install all door alarm contacts in accordance with manufacturer's instructions either recessed in the door header or surface mounted as required. Provide wiring and connection to door alarm contact devices. Complete programming, adjustment and testing of all door alarm contacts.
- J. Install all duress switches in accordance with manufacturer's instructions, surface mounted under counter in locations shown on plans. Verify exact mounting location with Owner prior to cable rough-in or installation. For hard wired devices, provide wiring and connection to duress switch devices. For wireless duress switch devices, mount receivers in accessible locations. Complete programming, adjustment and testing of all duress switch devices. Wireless testing shall include signal reception when transmitter is in all sections of the area in which it will be used in normal operations.
- K. Install, wire, configure, adjust, program and test all access control system servers, workstations, badging workstations and other user interfaces.
- L. Install, wire, configure, adjust, program, and test all specified interfaces and integrations between access control and other systems. Contractor shall provide all cabling, wiring, terminations, components, devices, accessories, hardware, software and other material and accessories necessary to complete all specified interfaces and integrations and make them fully operational.
- M. All low voltage access control cabling shall be routed with other low voltage cabling and shall route through cable tray and non-continuous cable support pathways to the fullest extent possible.
- N. Electronic access control system cabling shall not be spliced.

- O. Flexible conduit is not allowed except with prior approval. Refer to Section 260533 for conduit requirements. Refer to Section 270528 for cable hanger and support requirements.
- P. Each cable shall be appropriately identified, as defined on the record documents, at each end's termination point using pressure sensitive label strips.
- Q. The conductor color code used in terminating system cabling at system devices shall remain consistent from device to device for each unique device type throughout the project.
- R. Install and tighten all connectors in accordance with manufacturer's instructions using the appropriately designed tools recommended by the manufacturer for that purpose. Do not strip or damage connectors, terminals, or equipment by over tightening termination fasteners.
- S. Grounding and Bonding Requirements:
 - 1. Provide a minimum of 6AWG bonding conductor from each electronic access control system control panel, power supply and surge suppression device to the nearest telecommunications grounding busbar. Actual bonding conductor size is determined by its length; refer to Section 270526 for grounding and bonding conductor sizing criteria.
 - 2. Cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground the shield only at the control panel end.
- T. Coordinate installation of all devices with other trades and utilities in the vicinity.
- U. Cabling shall be plenum rated when installed outside conduit in plenum ceilings.

3.2 FIELD QUALITY CONTROL

- A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system manufacturer. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system manufacturer.
- B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.
- C. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL) as suitable for purpose specified and indicated.

3.3 MANUFACTURER AND INTEGRATOR COMBINED FIELD SERVICES

- A. Installation shall be performed by a factory-trained and certified Contractor.

- B. The Contractor shall provide a comprehensive, site-specific customer planning guide for the system. The Contractor shall conduct conference(s) with the Owner prior to any installation to discuss the programming and configuration options of the system and the planning guide.
- C. The Contractor shall include labor for all planning and all programming activities required to implement the Owner's access policies for each system point and each operator and administrator. Any software programmable access policy, within the bounds of the hardware specified, shall be included.
- D. It shall be the responsibility of the Contractor to provide a complete, functional system as described by the design documents. These responsibilities include:
 - 1. Complete hardware setup, installation, wiring and software configuration of the system server, all workstations and all peripheral hardware.
 - 2. Configuration of the network software for operation of the system. Templates shall be established representative of all user access right levels.
 - 3. Programming of all custom graphic GUI screens including devices.
 - 4. Complete system diagnostic verification.
- E. The SMS Installation Contractor shall be present at meetings to coordinate all door hardware requirements with the door hardware vendor.

3.4 SYSTEM DOCUMENTATION

- A. Complete documentation shall be provided for the system. The documentation shall describe:
 - 1. All operational parameters of the system
 - 2. Complete documentation of programming and access policies
 - 3. Complete operating instructions for all hardware and software
- B. The following sections shall be provided in the system documentation:
 - 1. System Administrator Manual: Provides an overview and a step-by-step guide and instructions detailing all system administrator responsibilities and functions.
 - 2. User Manual: A step-by-step guide and instructions detailing all system user functions.
 - 3. Alarm Monitoring Manual: A step-by-step guide and instructions detailing all alarm monitoring system functions and responsibilities.
 - 4. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams and schematic diagrams.
 - 5. Refer to Part 1 for details.

3.5 SYSTEM ACCEPTANCE

- A. The SMS vendor shall submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components, software and functionality. The Contractor shall perform the tests and document all results under the supervision of the manufacturer's systems engineer.
- B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.
- C. The system shall not be accepted until all requirements of system documentation and training have been completed.

END OF SECTION

SECTION 283100 - FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire alarm and detection systems.

1.2 RELATED WORK

- A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.
- B. Section 280537 - Distributed Antenna System (DAS) for Public Safety Networks.

1.3 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years' experience.
- B. Installer: A factory-authorized Electrical or Security Contractor licensed with the State and local jurisdiction with five years' experience in the design, installation, and maintenance of fire alarm systems by that manufacturer.
- C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 3. This person's name and certification number shall appear on the start-up and testing reports.

1.4 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)
- B. NFPA 72 - National Fire Alarm and Signaling Code
- C. NFPA 101 - Life Safety Code
- D. UL 2017 - General Purpose Signaling Devices and Systems
- E. UL 217 / 268 - Standard for Smoke Alarms / Smoke Detectors for Fire Alarm Systems

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 260500 and as noted below.
 - 1. Failure to comply with all the following and all the provisions in 26 05 00 will result in the shop drawing submittal being rejected without review.

2. Failure to submit the fire alarm without all requirements fulfilled in a single comprehensive submittal will be grounds to require a complete resubmittal.
- B. Provide product catalog data sheets as shop drawings.
1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings, but required for the operation of the system.
 2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.
 3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.
- C. Submit CAD Floor Plans as Shop Drawings:
1. The complete layout of the entire system, device addresses, auxiliary equipment, and manufacturer's wiring requirements shall be shown.
 2. Indicate the precise routing of notification appliance circuits under the provisions of circuit survivability. Refer to "Wiring" under Part 3 - Execution of this specification section for requirements.
 3. A legend or key shall be provided to show which symbols shown on the submittal floor plans correspond with symbols shown on the Contract Documents.
- D. About all fire alarm circuits, provide the following: manufacturer's wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.
- E. Provide installation and maintenance manuals under provisions of Section 260500.
- F. Submit manufacturer's certificate that system meets or exceeds specified requirements.
- G. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.
- H. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.
- I. When required to comply with local or state regulatory reviews, the fire alarm submittal shall have a Professional Engineer's stamp and signature of the state in which the project is completed. NOTE: The Architect/Engineer cannot stamp and seal submittal drawings not prepared under their supervision.
- 1.6 EXTRA MATERIALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide quantity equal to 2 percent (2%) of amount of each type installed, but no less than two (2) units of each type.
 - a. Smoke and heat detectors, manual pull stations, duct smoke detectors, monitor modules, control modules and relays.
 - b. Notification Appliances: Speakers, speaker strobes, and strobes.
2. Keys: The installing contractor shall collect all equipment spare keys provided with each lockable or resettable device/cabinet minimum of one (1) set each and shall turn over to the Owner upon completion.
3. All spare parts shall be housed in metal cabinet labeled "Fire Alarm Spare Parts."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 260500.
- B. Store and protect products under provisions of Section 260500.

1.8 REGULATORY REQUIREMENTS

- A. System: UL or FM Global listed.
- B. Conform to requirements of NFPA 101.
- C. Conform to requirements of Americans with Disabilities Act (ADA).
- D. Conform to UL 864 Fire Alarm, UL 1076 Security, UL2017 General Signaling, and UL 2572 Mass Notification Communications.

1.9 SYSTEM DESCRIPTION

- A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
- B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.

- C. Extending the Existing Fire Alarm System: Provide all items, components, devices, hardware, software, programming, expansion components, conduit, wiring etc. needed to extend the existing fire alarm system. This includes, but is not limited to, additional power supplies, initiating devices and circuits, signaling devices and circuits, monitoring devices and circuits, auxiliary control and related devices such as, door holders and their control, smoke damper control, fan shutdown, etc. The existing fire alarm system shall be extended such that the existing fire alarm system's functionality, integrity and annunciation shall be equivalent to pre-construction conditions, unless noted otherwise. The functionality and integrity shall be maintained during construction. The entire system shall be able to be completely reset from any single reset location point. The entire system shall be annunciated at any annunciation location.
 - D. Extending the Existing Fire Alarm System: The existing control panel shall remain and shall be operational throughout construction. The system shall only be disabled to make new connections and to modify the programming. A fire watch shall be provided for all areas affected during outages. All system outages must be scheduled with the Owner at least one week prior. Individual devices may be disabled as needed based on construction activities to reduce the potential for false alarms, but all devices must be operational when the Contractor is not physically on site. New initiating devices may be connected to the existing signaling line circuits where capacity is available. Provide additional signaling line circuits as needed based on existing and new device quantity, including replacement of existing panel components. Provide new notification circuits to serve the new devices, including all necessary power supplies, amplifiers, batteries, and 120-volt input circuits. All new devices shall be programmed to provide the same sequence of operation as the existing devices of the same type, unless noted otherwise.
 - E. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.
 - F. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.
 - G. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.
 - H. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.
 - I. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.
- 1.10 PROJECT RECORD DOCUMENTS
- A. Submit documents under the provisions of Section 260500.

- B. Include location of end-of-line devices.
- C. Provide a CAD drawing of each area of the building (minimum scale of 1/16" = 1'-0") showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.
- D. Submit test results of sound pressure level (dBA) and intelligibility (STI) with the rooms tested designated on the floor plan. Notification devices shall have the tap wattage designated.

1.11 OPERATION AND MAINTENANCE DATA

- A. Submit data under provisions of Section 260500.
- B. Include operating instructions, and maintenance and repair procedures.
- C. Include results of testing of all devices and functions.
- D. Include manufacturer's representative's letter stating that system is operational.
- E. Include the CAD floor plan drawings.
- F. Include shop drawings as reviewed by the Architect/Engineer and the local Authority Having Jurisdiction.

1.12 WARRANTY

- A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.
- B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Siemens Fire Safety

2.2 FIRE ALARM PATHWAY CLASS AND SURVIVABILITY LEVEL

- A. Pathway Class:
 - 1. Pathway Class A: Circuits capable of transmitting an alarm signal during an open or a non-simultaneous single ground fault on a circuit conductor wiring system. Wiring of outgoing and return conductors shall be physically separated by a minimum of 50 feet or by a 2-hour rated enclosure.

B. Pathway Survivability Level:

1. Pathway Survivability Level 1: Circuits are protected by an automatic sprinkler system and installed in metal raceways.
2. Shared Pathway Designation Level 2: Provide physical segregation of all life safety and non-life safety data.

2.3 SIGNALING LINE CIRCUIT DEVICES

A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.

B. Signal Line Device(s):

1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
 - a. Device type as follows:
 - 1) W = Weatherproof
 - 2) WG = Wire guard is required
 - 3) Candela Ratings:
 - a) ## = 15 Candela, 30 Candela; 75 Candela; 110 Candela; 177 Candela
 - b) CD = NICET designer shall select Candela rating as required to provide full coverage of the space.
 - b. Sequence of operation as follows:
 - 1) A = Atrium
 - 2) CA = Clean Agent System
 - 3) CR = Computer Room
 - 4) E = Elevator Recall
 - 5) D = HVAC Control
 - 6) DH = Door Hold Release
 - 7) DIPS = Dual Interlock Pre-Action System
 - 8) FD = Fire Door Release
 - 9) MP = Medical Procedure Room
 - 10) S = Sleeping / Patient Room
 - 11) SW = Stairwell

C. FA-120; Smoke Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.

- a. Device types as follows:
 - 1) Blank = Photoelectric
 - 2) ID = In-Duct Detector
2. (BLANK) Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
3. (IN) In-Duct Smoke Detectors:
 - a. Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
 - b. Analog Ionization Type Sensor: Shall use the dual chamber ionization principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
 - c. Low Flow Type: Listed for use in duct with 0-2000 feet per minute velocity.
 - d. Each smoke detector shall connect directly to an SLC loop.
 - e. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided to match the duct application. Provide a two-piece head/base design.
 - f. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
 - g. Provide a remote LED indicator device (FA-240/241), mounted in ceiling directly below detector with a single-gang faceplate labeled: Duct Smoke Detector.
4. Each smoke detector shall connect directly to an SLC loop, unless listed as stand alone.
5. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.
6. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
7. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.
8. A test means shall be provided to simulate an alarm condition.
9. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.
10. Audible Sounder Detector Base for Sleeping Room Applications:
 - a. The audible base shall sound an alarm in the local room in UL2017 operation and UL484 for general evacuation. The unit shall be programmable by the main control panel for the duration of operation.

- b. The audible sounder base shall sound Temporal 3 (fire) or Temporal 4 (CO alarm) and be at 75 dB at 10 feet.

D. FA-130; Manual Pull Stations:

- 1. Manual pull station, addressable, single action, reset key lock, semi-flush mount, red high abuse plastic or cast metal construction with white lettering. Provided with all necessary mounting hardware.
- 2. Manual stations shall connect directly to an SLC loop. Stations shall provide address setting means using rotary decimal or DIP switches.
- 3. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location, with maintained temperatures between 32°F and 120°F.

E. FA-161; Addressable Control Module:

- 1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
 - a. Device types as follows:
 - 1) Blank = Refer to Plans
 - 2) DH = Door Hold Open
 - 3) PD = Hold Open Override
- 2. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional child relay(s), as required, rated for the electrical load being controlled (Contractor to match voltage, amps, etc.).
- 3. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.
- 4. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.
- 5. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

2.4 NOTIFICATION APPLIANCE DEVICES

- A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.
- B. Notification Appliance Device(s):
 - 1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
 - a. Device types as follows:

- 1) W = Weatherproof
 - 2) WG = Wire guard is required
 - 3) Candela Ratings:
 - a) ## = 15 Candela; 30 Candela; 75 Candela; 110 Candela; 177 Candela
 - b) CD = NICET designer shall select Candela rating as required to provide full coverage of the space.
- b. Sequence of operation as follows:
- 1) S = Sleeping / Patient Room

C. Notification Device(s):

1. Wall Mounted: Red housing with white lettering or pictogram.
2. Ceiling Mounted: White housing with red lettering or pictogram.

D. FA-200; Visual Alarm Devices:

1. Wall or ceiling mounted, refer to plans.
2. High intensity (Candela rating as scheduled on the drawings) xenon strobe or equivalent under a lens. Candela rating shall be visible from exterior of the device.
3. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.
4. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.
5. (W) Weatherproof Visual Notification Device: High intensity strobe, square housing, 75 Candela rating, suitable for wet locations. Provide with weatherproof back box.
 - a. Mounting: Semi-flush wall.
 - b. Conduit shall not be exposed.

E. FA-211; Combination Audio Chime and Visual Alarm Device:

1. Wall or ceiling mounted, refer to plans.
2. Combine audio and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.
3. (W) Weatherproof Audio/Visual Notification Device: Electronic horn with high intensity strobe, square housing, 75 Candela, suitable for wet locations. Provide with weatherproof back box.
 - a. Mounting: Semi-flush wall.
 - b. Conduit shall not be exposed.

2.5 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS

A. FA-250; Smoke and Fire/Smoke Damper Controller:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
 2. Device types as follows:
 - a. + = Indicates equipment system associated with smoke or fire/smoke damper.
 3. Motorized type, 120 VAC, furnished and installed by MC. Fire alarm control and power connections by EC. A subscript is used to identify the device with a specific air handler or zone for its sequence of operation. Refer to the Fire Alarm Operation Matrix on the drawings and the sequence of operation descriptions in this specification section for additional requirements.
 4. The EC provides:
 - a. Fire alarm control and power connections by EC.
 - b. Fire alarm addressable control module (FA-161) located within 5 feet of smoke damper.
 - c. Smoke detection, selected by NICET designer based on duct size, ventilation airflow, and specific field conditions. Detector shall be mounted within 5 feet of smoke damper. Approved options include:
 - 1) Smoke Detector (FA-120) (ID) In-Duct Detector. In-duct smoke detector in ducts less than 18". Detector shall be listed for use in HVAC ductwork.
 - 2) Duct Smoke Detector (FA-122). Sampling type duct detector (FA-122) in ducts 18" and larger.
 - d. Remote indicator (FA-241) or Remote Indicator with test switch (FA-242) mounted in visible location. Refer to drawings for mounting location or verify location with engineer when not shown.
 - e. The smoke damper shall close upon activation of the detector, and a supervisory signal shall be sent to the fire alarm control panel. Refer to the Fire Alarm Operation Matrix and these specifications for complete requirements.
- B. FA-263; Electronic Bell:
1. Electronic bell for sprinkler alarm, electro-mechanical type, 120 VAC. Furnished and installed by MC. Fire alarm control and power connections by EC.
- C. FA-271; Door Hold Device:
1. Subscript: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
 - a. DH - Door Hold Open
 - b. PD = Hold Open Override
 2. (BLANK) Integral with door hardware, 120 VAC. Furnished and installed by GC. Fire alarm control and power connections by EC.

3. (PD) Hold open override connection to GC-provided power door operator. EC shall intercept the hold open switch wiring (unless specific contacts for this purpose are provided on the door) and connect addressable relay to override this switch and allow the door to close. All modifications to the power door operator shall be coordinated with the GC.

D. FA-161; Lighting Control Override:

1. Subscript: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
 - a. LC = Lighting Control Override
2. The lighting control system(s) is equipped with a remote input fire alarm override contact to allow the fire alarm system via an output relay to override the lighting control sequence of operation upon a fire alarm "alarm" condition. The fire alarm system will provide addressable fire alarm output relay(s) to interface with the lighting control system. Coordinate the location and quantity of relays required with the lighting control system.
3. Provide (FA-161) fire alarm addressable control module for each interface required for the lighting control system.

2.6 WIRING

- A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with the Electrical Code for power-limited fire alarm signal service.
- B. Fire Alarm Cable:
 1. Manufacturers:
 - a. Comtran Corp.
 - b. Helix/HiTemp Cables, Inc.
 - c. Rockbestos-Suprenant Cable Corp.
 - d. West Penn Wire/CDT.
 - e. Radix.

PART 3 - EXECUTION

3.1 SEQUENCES OF FIRE ALARM OPERATION

- A. General:
 1. Refer to the Fire Alarm Operation Matrix on the drawings for basic requirements and system operation.

2. The GUI/graphic annunciator shall display audible and visual alarms. The device activated shall be immediately displayed on a CAD floor plan at approximately 1/8" scale. Visual indication shall further indicate the device by utilizing an easily recognized color change of the symbol. The use of flashing symbols is encouraged.
 3. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
- B. Panel/Annunciator Alarm, Trouble, Supervisory Indication:
1. Appropriate system Alarm, Trouble, or Supervisory LED shall flash at the control panel, transponder, and annunciator locations.
 2. A local signal in the control panel shall sound.
 3. The LCD display shall indicate all information associated with the condition, including the name of the item, type of device and its location within the protected premises.
 4. history storage equipment shall log the information associated with the fire alarm control panel (FAP) condition, along with the time and date.
 5. Transmit the appropriate signal (supervisory, trouble, alarm) to the central station via the digital communicator.
 6. Transmit the appropriate signal (supervisory, trouble, alarm) to the building automation system via addressable relays tied to contact monitors on the system.
- C. Audible Alarms Sequence:
1. Audible alarms throughout the building shall sound.
 2. Separate voice announcements shall be played in different fire compartments depending on proximity to the device that initiated the alarm. Refer to the requirements above for the Voice Command Center programming.
- D. Visual Alarms Sequence:
1. Visual alarms throughout the building shall flash.
- E. Nurse Station Annunciation Sequence:
1. The fire alarm system shall provide annunciation of device and room in alarm at fire alarm annunciator located at the nurse station serving the patient room in alarm.
 2. The fire alarm device shall utilize local contacts to signal the nurse call system. The nurse call system shall annunciate the alarm at the nurse call station through software control of the nurse call system. Coordinate with the nurse call supplier to provide the necessary interface and programming.
 3. The nurse call system shall illuminate the red compartment of the nurse call dome light through the software control of the nurse call system. Coordinate with the nurse call supplier to provide the necessary interface and programming.

F. Fire Protection Electric Sprinkler Bell Sequence:

1. The fire alarm shall utilize an addressable relay to energize the electric sprinkler bell upon activation of the flow switch.

G. HVAC System Sequence:

H. Smoke Damper Control Sequence:

1. The fire alarm system shall utilize an addressable relay to open the power connection to smoke or fire/smoke dampers and allow them to close. Coordinate other requirements with damper installer.
2. Where a damper is in a main air duct, where closure of that single damper will entirely block airflow in the duct system, the smoke damper sequence shall also initiate the AHU and mechanical fan shutdown sequence for the affected unit.
3. The AHU and mechanical fan shutdown sequence shall be initiated only when ALL the dampers associated with that unit or mechanical fan are closed. Otherwise, the AHU or mechanical fan shall continue to serve other areas.
4. Smoke and fire/smoke dampers located in branch ductwork shall be closed individually or in groups, as identified on the plans.

I. AHU and Mechanical Fan Shutdown Sequence:

1. The fire alarm system shall utilize addressable relays to de-energize all AHU motor controllers and mechanical fans. Coordinate other requirements with HVAC installer.
2. The fire alarm system shall directly shut down the AHU or mechanical fan through the local HVAC control device (i.e., variable frequency drive or motor starter).
3. Where a facility has more than one AHU or mechanical fan, each shall be shutdown individually based on input from initiation devices in the area served by the unit or designated for each air distribution system.

J. Fire Door Release Sequence:

1. The fire alarm system shall utilize an addressable relay to signal the fire door or curtain to close. Once the alarm is cleared, the addressable relay shall allow the door to open.
2. Where a facility has more than one fire door, each shall release individually based on input from initiation devices in the vicinity of each door and noted specifically for door closure.

K. Power-Operated Fire Doors Sequence:

1. The fire alarm system shall utilize an addressable relay to signal or disconnect power to the power-operated fire door, allowing automatic closing and latching of the door. Once the alarm is cleared, the addressable relay shall allow the door to open.
2. Door holders shall release individually based on initiation devices in the vicinity of the door and noted specifically for door closure.

L. Door Holder Release Sequence:

1. The fire alarm system shall utilize an addressable relay to open the power connection to integral and magnetic door holders.
2. The fire alarm system shall utilize an addressable relay to open the 'hold' switch circuitry, integral to the power door.
3. Door holders shall release individually based on initiation devices in the vicinity of the door and noted specifically for door closure.

M. Lighting Control Override Sequence: Coordinate requirements between the fire alarm and lighting control system.

1. The fire alarm shall use addressable output relay(s) to remotely override the local lighting control sequences of operation for egress, emergency, and life safety designated lighting. Coordinate the location and quantity of addressable output relays required with the lighting control shop drawings. Addressable fire alarm relays will be required, but not limited to, at the following locations:
 - a. Centralized, architectural, and theatrical lighting control panels.
 - b. Branch circuit lighting control zones, relays, automatic load control relays (ACLR), branch circuit emergency lighting transfer switches (BCELTSS).

N. Access Control Override Sequence:

1. The fire alarm shall use addressable output relay(s) to signal the access control panel.
2. Refer to the access control specifications for requirement upon fire alarm signal.

3.2 INSTALLATION

A. Install system in accordance with manufacturer's instructions and referenced codes.

B. Fire Alarm Control Panel:

1. Install the control panel where shown on the drawings.
2. All expansion compartments, if required, shall be located at the control panel.
3. Install the voice command center and fire command center in the location as indicated on the drawings. This location should be primary fire department "attack" location. Coordinate with the local fire department prior to submitting shop drawings.
4. The fire alarm voice prerecorded messages shall be verified by the Contractor, as approved by the Owner, prior to the shop drawing submittal process.

C. Devices:

1. General:
 - a. All ceiling-mounted devices shall be located where shown on the reflected ceiling and floor plans. If not shown on the reflected ceiling or reflected floor drawings, the devices shall be installed in the relative locations shown on the floor drawings in a neat and uniform pattern.

- b. All devices shall be coordinated with luminaires, diffusers, sprinkler heads, piping and other obstructions to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.
 - c. Where the devices are to be installed in a grid type ceiling system, the detectors shall be centered in the ceiling tile.
 - d. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall adjust location of device so that new location meets all requirements in NFPA 72 and all applicable building codes.
- 2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.
- 3. Protection of Fire Alarm System:
 - a. A smoke detector shall be installed within the vicinity of the main fire alarm panel and every NAC extender panel per NFPA 72. A heat detector may be substituted when a smoke detector is not appropriate for the environment of installation.
- 4. Analog Smoke and Heat Detectors:
 - a. In elevator shafts and elevator equipment rooms, provide a heat detector for elevator shutdown within 2' of every sprinkler head. Coordinate with fire protection contractor.
- 5. Duct-type Analog Smoke Detectors:
 - a. Duct-type analog smoke detectors shall be installed on the duct where shown on the drawings and details. The sampling tubes shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
 - b. All detectors shall be accessible.
 - c. Duct-type detectors shall be installed according to the manufacturer's instructions.
- 6. In-Duct Analog Smoke Detectors:
 - a. In-duct analog smoke detectors shall be installed in the duct where shown on the drawings and details. The devices shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
 - b. All detectors shall be accessible.

7. Heat Detector, Linear Wire Type:
 - a. Install detection wire within 20 inches of the underside of building roof, floor, or as recommended by the manufacturer.
 - b. The protected area shall not exceed 4,000 square feet per zone. Provide a separate zone for areas divided by fire/smoke rated walls.
8. Manual Pull Stations:
 - a. Stations shall be located where shown and at the height noted on the drawings.
9. Addressable Relays and Monitor Modules:
 - a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.
 - b. All modules shall be mounted in or on a junction box in an accessible location.
 - c. Where not visible from a floor standing position, a remote indicator shall be installed to allow inspection of the device status from a local floor standing location.
10. SLC Loop Isolation Modules:
 - a. Isolation modules shall be installed to limit the number of addressable devices that are incapacitated by a circuit fault.
 - b. Install all Isolation Modules within the fire alarm control panel, unless otherwise indicated on the drawings. Refer to the fire alarm riser diagram for requirements. Refer to the floor plans for areas served by separate isolation modules.
11. Notification Appliance Devices:
 - a. Devices shall be located where shown on the drawings.
 - b. Wall-mounted audio, visual and audio/visual alarm devices shall be mounted as denoted on the drawings.
 - c. Where ceiling mounted visual alarm devices or combination audio/visual alarm devices are shown where the ceiling is greater than 30'-0" high, they shall be stem mounted so that the entire unit is below 30'-0". This does not apply to audio-only alarm devices.

D. Annunciators:

1. Color Graphics Annunciation System: The annunciator shall be installed with custom graphics software showing the floor plan of the entire building and shall include a close approximation of the location of all devices in the system. The annunciator shall be located approximately where shown on the drawings as directed by the Owner. Each smoke compartment zone, (refer to architectural drawings) as a minimum, shall be on a single screen. A screen shall be created depicting an overall plan indicating the entire facility and the quantity of floors or zones that will clearly indicate the area(s) the alarm(s) are being reported.

2. Remote Annunciators: The annunciators shall be located where shown on the drawings and approved by the fire marshal.

E. Wiring:

1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes.
2. Wiring shall be installed in conduit.
3. All junction boxes with SLC and NAC circuits shall be identified on cover.
4. Partial evacuation or relocation of occupants is the standard operating procedure for this facility in the event of an alarm. Therefore, all notification appliance circuits (NAC), including circuits serving NAC extender panels and other network communication circuits, must be installed and protected in accordance with the "circuit survivability" requirements described in NFPA 72. Contractor shall maintain the following:
 - a. NACs serving separate evacuation signaling zones shall be routed separately such that they are no less than 4 feet apart when run horizontally and 1 foot apart when run vertically. They may come simultaneously only within 10 feet of the control panel.
 - b. NACs passing through other evacuation signaling zone(s) shall be installed in conduit and routed through the 2-hour fire-rated chase(s) or enclosure(s) identified on the drawings.
5. Fire Alarm Power Branch Circuits: Building wiring as specified in Section 260513.
6. Notification Appliance Circuits shall provide the features listed below. These requirements may require separate circuits for visual and audible devices.
 - a. Fire alarm temporal audible notification for all audio appliances.
 - b. Synchronization of all visual devices where two or more devices are visible from the same location.
 - c. Ability to silence audible alarm while maintaining visual device operation.
 - d. Emergency communication alert and textual visible appliance notification.
7. Notification Appliance Circuits shall not span floors or smoke compartments. Refer to architectural drawings for smoke compartments.
8. Signal line circuits connecting devices shall not span floors or 2-hour smoke compartments.
9. Signal line circuits connecting devices shall be provided with an isolation module at each floor separation or as otherwise shown on the drawings.
10. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device with "E-Z Markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.

- F. Fire Alarm Cabling Color Code: Provide circuit conductors with insulation color coding as follows, or using colored tape at each conductor termination and in each junction box.
 - 1. Power Branch Circuit Conductors: In accordance with Section 260553.
 - 2. Signaling Line Circuit: Overall red jacket with black and red conductors.
 - 3. DC Power Supply Circuit: Overall red jacket with violet and brown conductors.
 - 4. Notification Appliance Circuit: Overall red jacket with blue and white conductors.
 - 5. Door Release Circuit: Gray conductors.
 - 6. Central Station Trip Circuit: Orange conductors.
 - 7. Central Station Fire Alarm Loop: Black and white conductors.
- G. Devices surface mounted in finished areas shall be mounted on surface backboxes furnished by fire alarm equipment supplier. Backboxes shall be painted to match device, shall be the same shape and size as the device shall not have visible knockouts.
- H. Make conduit and wiring connections to door release devices, sprinkler flow and pressure switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer's product data and shop drawings.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 260500.
- B. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.
- C. Contractor shall test and adjust the fire alarm system as follows:
 - 1. Speaker taps shall be adjusted to the lowest tap setting which achieves a sound level higher than or equal to the greatest of the following:
 - a. 70dBA.
 - b. 15 dBA above ambient levels as indicated in NFPA 72 Table A.18.4.3.
 - c. 15 dBA above measured ambient. 5 dBA above the maximum measured sound level with duration of more than 60 seconds.
 - d. As specified on the drawings.
 - 2. Sound level measurement procedure shall meet the following requirements:
 - a. All measurements shall use the 'A' weighted, dBA, sound measurement scale.
 - b. All measurements shall be taken after furnishings, wall coverings and floor coverings are in place.
 - c. All measurements shall be taken after fixed equipment (HVAC units, etc.) producing ambient noise is installed and is in operation.

- d. All sound level measurements shall be taken at a height of 5' above the finished floor level.
- e. Measurements shall be taken in every unique room. If there are multiple rooms, which have the identical dimensions and function, 10%, or a minimum of two (2) rooms shall be tested. The results from the rooms tested shall be averaged and the remaining rooms may be adjusted per the average.
- f. Measurements shall be taken on a 20' x 20' grid and the results for all points taken shall be averaged. If the room is smaller than 20' x 20' a minimum of two measurements are required.
- g. Measurements shall be taken halfway between speakers or halfway between a speaker and the wall. No measurements shall be taken at the extreme edges of the room, nor directly under speakers.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Provide manufacturer's field services under provisions of Section 260500.
- B. Include services of the manufacturer's software programmer to write initial custom-user program (for Color Graphics Annunciation System).
- C. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.
- D. Note that room numbers depicted on the architectural/engineering drawings will not necessarily reflect the actual room (signage) numbers that the Owner selects. Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Owner directs to identify each device. This list shall be a part of the floor plan record drawing to be turned in at the project closeout.

3.5 SYSTEM TRAINING

- A. System training shall be performed under provisions of Section 260500.
- B. Minimum on-site training times shall be:
 - 1. System Operators: One (1) day.

END OF SECTION