SPECIFICATIONS for

Clark County Public Library

CCPL Northridge Branch

Springfield, OHIO

Volume 1 of 1

General, Architectural, Mechanical & Electrical Requirements

For Bidding & Permitting

February 23, 2024

PREPARED BY

LUMINAUT

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Project No. IN23021 Issued February 23, 2024

SECTION 00 01 10
TABLE OF CONTENTS

PROCUREMENT AND CONTRACTING REQUIREMENTS

1.1 DIVISION 00 -- PROCUREMENT AND CONTRACTING REQUIREMENTS

A. TOC - Table of Contents

B. 00 00 02 - Notice to Bidders

C. 00 01 00 - Instructions to Bidders (AIA 701 - 2018)

D. 00 03 00 - Bid Form

E. 00 04 10 - Schedule of Subcontractors and Material Suppliers

F. 00 05 00 - Standard Form of Agreement (AIA A101 - 2017)

G. 00 06 00 - Exhibit A, Insurance and Bonds (AIA A101 - 2017)

H. 00 07 00 - General Conditions (AIA A201 - 2017)

SPECIFICATIONS

2.1 DIVISION 01 -- GENERAL REQUIREMENTS

A. 01 01 00 - Summary of Work

B. 01 09 00 - General Commissioning

C. 01 21 00 - Allowances

D. 01 22 00 - Unit Prices

E. 01 25 00 - Substitution Procedures (CSI Form)

F. 01 31 19 - Meetings and Schedules

G. 01 33 00 - Submittals

H. 01 35 00 - Operating and Maintenance Manual

I. 01 40 00 - Quality Control Service

J. 01 50 00 - Temporary Facilities and Controls

K. 01 71 00 - Project Closeout

L. 01 72 00 - Project Record Documents

M. 01 73 29 - Cutting and Patching

N. 01 74 00 - Project Cleaning

2.2 DIVISION 02 -- EXISTING CONDITIONS (NOT USED)

2.3 DIVISION 03 -- CONCRETE

A. 03 30 00 - Cast-in-Place Concrete

B. 03 35 11 - Concrete Floor Finishes

2.4 DIVISION 04 -- MASONRY

A. 04 20 00 - Unit Masonry

B. 04 2001 - Masonry Veneer

C. 04 26 13 - Masonry Veneer

2.5 DIVISION 05 -- METALS

A. 05 12 00 - Structural Steel

B. 05 21 00 - Steel Joists

C. 05 31 00 - Steel Deck

D. 05 40 00 - Cold-Formed Metal Framing

E. 05 51 33 - Metal Ladders

F. 05 52 13 - Pipe and Tube Railings

G. 05 53 00 - Metal Grating

2.6 DIVISION 06 -- WOOD, PLASTICS, AND COMPOSITES

A. 06 10 00 - Rough Carpentry

B. 06 41 00 - Architectural Wood Casework

C. 06 42 00 - Wood Paneling

2.7 DIVISION 07 -- THERMAL AND MOISTURE PROTECTION

A. 07 05 23 - Pressure Testing

B. 07 14 00 - Fluid-Applied Waterproofing

C. 07 21 00 - Thermal Insulation

D. 07 25 00 - Weather Barriers

E. 07 26 00 - Vapor Retarders

F. 07 42 13.23 - Metal Composite Material Wall Panels

G. 07 46 46 - Fiber-Cement Siding

H. 07 53 00 - Elastomeric Membrane Roofing

I. 07 62 00 - Sheet Metal Flashing and Trim

J. 07 72 00 - Roof Accessories

K. 07 92 00 - Joint Sealants

2.8 DIVISION 08 -- OPENINGS

A. 08 11 13 - Hollow Metal Doors and Frames

B. 08 14 16 - Flush Wood Doors

C. 08 43 13 - Aluminum-Framed Storefronts

D. 08 44 13 - Glazed Aluminum Curtain Walls

E. 08 80 00 - Glazing

F. 08 87 23 - Safety and Security Films

2.9 DIVISION 09 -- FINISHES

A. 09 05 61 - Common Work Results for Flooring Preparation

B. 09 21 16 - Gypsum Board Assemblies

C. 09 30 00 - Tiling

D. 09 51 00 - Acoustical Tile Ceilings

E. 09 51 26 - Suspended Wood Veneer Ceilings

F. 09 65 00 - Resilient Flooring

G. 09 68 13 - Tile Carpeting

H. 09 72 00 - Wall Coverings

I. 09 91 13 - Exterior Painting

J. 09 91 23 - Interior Painting

K. 09 93 00 - Staining and Transparent Finishing

2.10 DIVISION 10 -- SPECIALTIES

A. 10 11 00 - Visual Display Units

B. 10 14 16 - Plaques

C. 10 14 23 - Panel Signage

D. 10 26 00 - Wall and Door Protection

E. 10 28 00 - Toilet, Bath, and Laundry Accessories

F. 10 44 00 - Fire Protection Specialties

G. 10 51 29 - Phenolic Lockers

H. 10 75 00 - Flagpoles

I. 10 82 15 Through Wall Book Return

2.11 DIVISION 11 -- EQUIPMENT

A. 11 51 23 - Steel Library Shelving

2.12 DIVISION 12 -- FURNISHINGS

A. 12 36 00 - Countertops

B. 12 93 13 - Bicycle Racks

2.13 DIVISION 13 -- SPECIAL CONSTRUCTION (NOT USED)

2.14 DIVISION 14 -- CONVEYING EQUIPMENT (NOT USED)

2.15 DIVISION 21 -- FIRE SUPPRESSION (NOT USED)

2.16 DIVISION 22 -- PLUMBING

A. 22 000 0- Plumbing Index

B. 22 05 01 - Common Work Results for Plumbing

C. 22 05 07 - Excavation and Backfill.

D. 22 05 13 - Common Motor Requirements for Plumbing Equipment

E. 220519- Meters and Gauges for Plumbing Piping

F. 22 05 23 - General-Duty Valves for Plumbing Piping

G. 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment

H. 22 05 48 - Vibration Controls for Plumbing Piping and Equipment

I. 22 05 53 - Identification for Plumbing Piping and Equipment

J. 22 05 61 - Preparation of Plumbing Systems

K. 22 05 93 - Plumbing Systems Testing, Adjusting, And Balancing

L. 22 07 00 - Plumbing Insulation

M. 221116 - Domestic Water Piping

N. 22 13 13 - Facility Sanitary Sewers (Site)

O. 22 13 16 - Building Sanitary and Storm Drainage

P. 22 33 00- Domestic Water Heaters

Q. 22 40 00 - Plumbing Fixtures

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

A. 23 05 00 - General Mechanical Requirements

B. 23 05 14 - Variable Frequency Drives

C. 23 05 23 - Valves for HVAC Piping

D. 23 05 29 - Hangers, Sleeves, and Supports

E. 23 05 48 - Vibration Control for HVAC Piping

F. 23 05 53 - Identification for HVAC Piping and Equipment

G. 23 05 93 - Mechanical Systems Testing, Adjusting, and Balancing

H. 23 07 00 - HVAC Insulation

I. 23 08 00 - Comissioning of HVAC Systems

J. 23 09 00 - Instrumentation and Control for HVAC

K. 23 21 00 - Excavation, Trenching, Backfilling, and Grading

L. 23 21 13 - Hydronic Piping

M. 23 21 16 - Hydronic Specialities

N. 23 21 23 - Hydronic Pumps

O. 23 23 00 - Ground Loop Heat Pump Piping

P. 23 25 00 - HVAC Water Treatment, Cleaning, Filling, and Purging

Q. 23 30 00 - Ductwork and Accessories

R. 23 34 00 - HVAC Fans

S. 23 74 33 - Dedicated Outdoor Air Units

T. 23 81 49 - Ground Source Heat Pumps

U. 23 82 36 - Electric Baseboard Heaters

V. 23 82 39 - Unit Heaters

2.18 DIVISION 24 -- RESERVED (NOT USED)

2.19 DIVISION 25 -- INTEGRATED AUTOMATION (NOT USED)

2.20 DIVISION 26 -- ELECTRICAL

A. 26 00 00 - CMTA Electrical Master Index

B. 26 00 10 - General Requirements for Electrical Systems

C. 26 05 00 - Common Work Results for Electrical Systems

D. 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

E. 26 05 26 - Grounding and Bonding for Electrical Systems

F. 26 05 33 - Raceways & Boxes for Electrical Systems

G. 26 05 43 - Underground Ducts and Raceways for Electrical Systems

H. 26 05 53 - Identifications for Electrical Systems

I. 26 05 73 - Power System Studies

J. 26 09 23 - Lighting Control Devices

K. 26 24 16 - Panel Boards

L. 26 27 26 - Wiring Devices

M. 26 28 13 - Fuses

N. 26 28 16 - Enclosed Switches and Circuit Breakers

O. 26 29 00 - Motor Controllers

P. 26 41 00- Facility Lighting Protection

Q. 26 43 00 - Surge Protection Devices

R. 26 50 00- Lighting

2.21 DIVISION 27 -- COMMUNICATIONS

A. 27 00 00 - Voice Data Systems

2.22 DIVISION 28 -- ELECTRONIC SAFETY AND SECURITY

A. 28 13 00 - Access Control Syste

B. 28 23 00 - Video Surveillance Systems

C. 28 46 13- Addressable Fire Alarm Systems

D. 28 51 29- Emergency Responder Communication Enhancement System

2.23 DIVISION 31 -- EARTHWORK

A. 31 10 00 - Site Clearing

B. 31 20 00 - Earth Moving

2.24 DIVISION 32 -- EXTERIOR IMPROVEMENTS

A. 32 12 16 - Asphalt Paving

B. 32 13 13 - Concrete Paving

C. 32 13 73 - Concrete Paving Joint Sealant

D. 32 92 00 - Turf and Grasses

2.25 DIVISION 33 -- UTILITIES

A. 33 41 00 - Storm Utility Drainage Pi

END OF SECTION 00 01 10

SECTION 22 00 00
PLUMBING INDEX

DIVISION 22 – PLUMBING

220501 - Common Work Results for Plumbing
220507 - Excavation and Backfill
220513 - Common Motor Requirements for Plumbing Equipment
220519 - Meter and Gauges for Plumbing Piping
220523 - General-Duty Valves for Plumbing Piping
220529 - Hangers and Supports for Plumbing Piping and Equipment
220548 - Vibration Controls for Plumbing Piping and Equipment
220533 - Identification for Plumbing Piping and Equipment
220561 - Preparation of Plumbing Systems
220593 - Plumbing Systems Testing, Adjusting, and Balancing
220700 - Plumbing Insulation
221116 - Domestic Water Piping
221316 - Building Sanitary and Storm Drainage
223300 - Domestic Water Heaters
224000 - Plumbing Fixtures

INDEX

DIVISION 26 – ELECTRICAL

260010 – GENERAL REQUIREMENTS FOR ELECTRICAL SYSTEMS
260500 – COMMON WORK RESULTS FOR ELECTRICAL SYSTEMS
260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260533 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
260543 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS
260573 – POWER SYSTEM STUDIES
260923 – LIGHTING CONTROL DEVICES
262416 – PANELBOARDS
262726 – WIRING DEVICES
262813 – FUSES
262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS
262900 – MOTOR CONTROLLERS
264100 – FACILITY LIGHTNING PROTECTION
264300 – SURGE PROTECTIVE DEVICES
265000 – LIGHTING

DIVISION 27 – COMMUNICATIONS

270000 – VOICE DATA SYSTEMS

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

281300 – ACCESS CONTROL SYSTEMS
282300 – VIDEO SURVEILLANCE SYSTEMS
284613 – ADDRESSABLE FIRE ALARM SYSTEMS
285129 – EMERGENCY RESPONDER COMMUNICATION ENHANCEMENT SYSTEM

NOTICE TO BIDDERS

PART 1 - GENERAL

Sealed bid proposals for **Clark County Public Library Northridge Branch** will be received by the Fiscal Officer of Clark County Public Libraries Board of Trustees at the office of the main Clark County Public Library, 201 South Fountain Avenue, Springfield, Ohio 45506, until **12:00 pm, local time on March 18, 2024.**

Bids shall be delivered in a sealed envelope indicating "Sealed Bid Enclosed", the Bidder's name and address, the name and phone number of the Bidder's contact person, and "Clark County Public Library Northridge Branch." The bids shall be noted for date and time upon receipt. All bids shall be publicly opened and read aloud on March 18, 2024 at 4:00pm during the monthly Clark County Public Library Board meeting. Bids received after 12:00pm March 18, 2024 will be returned unopened.

The CCPL Northridge Branch New Construction work will be executed under a single Prime Contract, executed on a lump sum basis. The Work shall include but not limited to

1. New ground up construction of 9,400 square foot steel structure, supported on shallow foundations,
2. Clad in masonry, cement board, metal panel, and storefront/ curtain wall,
3. Full site work including, parking, stormwater management, new sanitary/ sewer, and geothermal wellfield,
4. Distributed ground source heat pumps and DOAS,
5. New primary electrical service, including LED lighting, technology, and miscellaneous equipment,
6. Interior gypsum board partitions and finishes,
7. Steel library shelving, and
8. Custom millwork throughout the project.

Estimated project construction cost:
Base Bid + Add Alternates: $4,800,000

In accordance with Plans and Specifications prepared by:

Luminaut
1100 Sycamore Street #200
Cincinnati, Ohio 45202
Phose: 513-984-1070
Website: www.luminaut.com
Contact: Erin Jennings
Email: ejennings@luminaut.com

A **pre-bid meeting is scheduled for February 28, at 10:00 am** local time. Interested parties may assemble at the CCPL Main Library Branch: 201 South Fountain Avenue, Springfield, Ohio, 45506. Prospective bidders are requested to attend.

Online and Printed Procurement and Contracting Documents: Obtain on or after **February 23**, 2024 by contacting Builders Exchange, Inc., 9555 Rockside Road, Suite 300 Valley View, Ohio 44125, www.bxohio.com, 216-363-6300. Online access will be provided to all registered bidders and suppliers. Only complete sets of documents will be issued. Costs associated with digital and printed plans and specification obtained will be incurred at the expense of the Bidder and are non-refundable.

Neither Owner nor Architect has any responsibility for the accuracy, completeness or sufficiency of any bid documents obtained from any source other than the source indicated in this document. Obtaining these documents from any other source(s) may result in obtaining incomplete and inaccurate information. Obtaining these documents from any source other than directly from the source listed herein may also result in failure to receive any addenda, corrections, or other revisions to these documents that may be issued.

Bids shall be received on the Form of Bid Proposal furnished and accompanied by the required supporting documents listed within the Instruction to Bidders. No other form(s) will be accepted.

Clark County Public Library reserves the right to waive irregularities in the bids and to reject any or all proposals or parts of any or all proposals.

No bidder may withdraw their bid within sixty (60) days after bid opening.

END OF SECTION 00 00 20

SECTION 00 01 00
INSTRUCTIONS TO BIDDERS

PART 1 GENERAL

1.1 INSTRUCTIONS TO BIDDERS

A. The instructions to bidders are as follows in document AIA 701 - 2018, as modified for the Owner for use on this project.

B. The Document is included as a part of this section.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 01 00

AIA® Document A701® – 2018

Instructions to Bidders

for the following Project:
(Name, location, and detailed description)

Clark County Public Library Northridge Branch
Moorefield Road
Springfield, Ohio 45503

THE OWNER:
(Name, legal status, address, and other information)

Clark County Public Library
201 South Fountain Avenue
Telephone Number: Springfield, Ohio 45506

THE ARCHITECT:
(Name, legal status, address, and other information)

Luminaut, Inc.
1100 Sycamore Street
Telephone Number: Suite 200
Fax Number: Cincinnati, Ohio 45202

TABLE OF ARTICLES

1 DEFINITIONS

2 BIDDER'S REPRESENTATIONS

3 BIDDING DOCUMENTS

4 BIDDING PROCEDURES

5 CONSIDERATION OF BIDS

6 POST-BID INFORMATION

7 PERFORMANCE BOND AND PAYMENT BOND

8 ENUMERATION OF THE PROPOSED CONTRACT DOCUMENTS

ADDITIONS AND DELETIONS:
The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

FEDERAL, STATE, AND LOCAL LAWS MAY IMPOSE REQUIREMENTS ON PUBLIC PROCUREMENT CONTRACTS. CONSULT LOCAL AUTHORITIES OR AN ATTORNEY TO VERIFY REQUIREMENTS APPLICABLE TO THIS PROCUREMENT BEFORE COMPLETING THIS FORM.

It is intended that AIA Document G612™–2017, Owner's Instructions to the Architect, Parts A and B will be completed prior to using this document.

ARTICLE 1 DEFINITIONS

§ 1.1 Bidding Documents include the Bidding Requirements and the Proposed Contract Documents. The Bidding Requirements consist of the advertisement or invitation to bid, Instructions to Bidders, supplementary instructions to bidders, the bid form, and any other bidding forms. The Proposed Contract Documents consist of the unexecuted form of Agreement between the Owner and Contractor and that Agreement's Exhibits, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, all Addenda, and all other documents enumerated in Article 8 of these Instructions.

§ 1.2 Definitions set forth in the General Conditions of the Contract for Construction, or in other Proposed Contract Documents apply to the Bidding Documents.

§ 1.3 Addenda are written or graphic instruments issued by the Architect, which, by additions, deletions, clarifications, or corrections, modify or interpret the Bidding Documents.

§ 1.4 A Bid is a complete and properly executed proposal to do the Work for the sums stipulated therein, submitted in accordance with the Bidding Documents.

§ 1.5 The Base Bid is the sum stated in the Bid for which the Bidder offers to perform the Work described in the Bidding Documents, to which Work may be added or deleted by sums stated in Alternate Bids.

§ 1.6 An Alternate Bid (or Alternate) is an amount stated in the Bid to be added to or deducted from, or that does not change, the Base Bid if the corresponding change in the Work, as described in the Bidding Documents, is accepted.

§ 1.7 A Unit Price is an amount stated in the Bid as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, as described in the Bidding Documents.

§ 1.8 A Bidder is a person or entity who submits a Bid and who meets the requirements set forth in the Bidding Documents.

§ 1.9 A Sub-bidder is a person or entity who submits a bid to a Bidder for materials, equipment, or labor for a portion of the Work.

ARTICLE 2 BIDDER'S REPRESENTATIONS

§ 2.1 By submitting a Bid, the Bidder represents that:

- **.1** the Bidder has read and understands the Bidding Documents;
- **.2** the Bidder understands how the Bidding Documents relate to other portions of the Project, if any, being bid concurrently or presently under construction;
- **.3** the Bid complies with the Bidding Documents;
- **.4** the Bidder has visited the site, become familiar with local conditions under which the Work is to be performed, and has correlated the Bidder's observations with the requirements of the Proposed Contract Documents;
- **.5** the Bid is based upon the materials, equipment, and systems required by the Bidding Documents without exception; and
- **.6** the Bidder has read and understands the provisions for liquidated damages, if any, set forth in the form of Agreement between the Owner and Contractor.

ARTICLE 3 BIDDING DOCUMENTS

§ 3.1 Distribution

§ 3.1.1 Bidders shall obtain complete Bidding Documents, as indicated below, from the issuing office designated in the advertisement or invitation to bid, for the deposit sum, if any, stated therein.
(Indicate how, such as by email, website, host site/platform, paper copy, or other method Bidders shall obtain Bidding Documents.)

Dayton Builders Exchange www.bxohio.com
Dodge Construction Network www.construction.com

§ 3.1.2 Any required deposit shall be refunded to Bidders who submit a bona fide Bid and return the paper Bidding Documents in good condition within ten days after receipt of Bids. The cost to replace missing or damaged paper documents will be deducted from the deposit. A Bidder receiving a Contract award may retain the paper Bidding Documents, and the Bidder's deposit will be refunded.

§ 3.1.3 Bidding Documents will not be issued directly to Sub-bidders unless specifically offered in the advertisement or invitation to bid, or in supplementary instructions to bidders.

§ 3.1.4 Bidders shall use complete Bidding Documents in preparing Bids. Neither the Owner nor Architect assumes responsibility for errors or misinterpretations resulting from the use of incomplete Bidding Documents.

§ 3.1.5 The Bidding Documents will be available for the sole purpose of obtaining Bids on the Work. No license or grant of use is conferred by distribution of the Bidding Documents.

§ 3.2 Modification or Interpretation of Bidding Documents

§ 3.2.1 The Bidder shall carefully study the Bidding Documents, shall examine the site and local conditions, and shall notify the Architect of errors, inconsistencies, or ambiguities discovered and request clarification or interpretation pursuant to Section 3.2.2.

§ 3.2.2 Requests for clarification or interpretation of the Bidding Documents shall be submitted by the Bidder in writing and shall be received by the Architect at least seven days prior to the date for receipt of Bids.
(Indicate how, such as by email, website, host site/platform, paper copy, or other method Bidders shall submit requests for clarification and interpretation.)

Erin Jennings, AIA,
ejennings@luminaut.com

§ 3.2.3 Modifications and interpretations of the Bidding Documents shall be made by Addendum. Modifications and interpretations of the Bidding Documents made in any other manner shall not be binding, and Bidders shall not rely upon them.

§ 3.3 Substitutions

§ 3.3.1 The materials, products, and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance, and quality to be met by any proposed substitution.

§ 3.3.2 Substitution Process

§ 3.3.2.1 Written requests for substitutions shall be received by the Architect at least ten days prior to the date for receipt of Bids. Requests shall be submitted in the same manner as that established for submitting clarifications and interpretations in Section 3.2.2.

§ 3.3.2.2 Bidders shall submit substitution requests on a Substitution Request Form if one is provided in the Bidding Documents.

§ 3.3.2.3 If a Substitution Request Form is not provided, requests shall include (1) the name of the material or equipment specified in the Bidding Documents; (2) the reason for the requested substitution; (3) a complete description of the proposed substitution including the name of the material or equipment proposed as the substitute, performance and test data, and relevant drawings; and (4) any other information necessary for an evaluation. The request shall include a statement setting forth changes in other materials, equipment, or other portions of the Work, including changes in the work of other contracts or the impact on any Project Certifications (such as LEED), that will result from incorporation of the proposed substitution.

§ 3.3.3 The burden of proof of the merit of the proposed substitution is upon the proposer. The Architect's decision of approval or disapproval of a proposed substitution shall be final.

§ 3.3.4 If the Architect approves a proposed substitution prior to receipt of Bids, such approval shall be set forth in an Addendum. Approvals made in any other manner shall not be binding, and Bidders shall not rely upon them.

§ 3.3.5 No substitutions will be considered after the Contract award unless specifically provided for in the Contract Documents.

§ 3.4 Addenda

§ 3.4.1 Addenda will be transmitted to Bidders known by the issuing office to have received complete Bidding Documents.

(Indicate how, such as by email, website, host site/platform, paper copy, or other method Addenda will be transmitted.)

Through online plan rooms hosting drawings.

§ 3.4.2 Addenda will be available where Bidding Documents are on file.

§ 3.4.3 Addenda will be issued no later than four days prior to the date for receipt of Bids, except an Addendum withdrawing the request for Bids or one which includes postponement of the date for receipt of Bids.

§ 3.4.4 Prior to submitting a Bid, each Bidder shall ascertain that the Bidder has received all Addenda issued, and the Bidder shall acknowledge their receipt in the Bid.

ARTICLE 4 BIDDING PROCEDURES

§ 4.1 Preparation of Bids

§ 4.1.1 Bids shall be submitted on the forms included with or identified in the Bidding Documents.

§ 4.1.2 All blanks on the bid form shall be legibly executed. Paper bid forms shall be executed in a non-erasable medium.

§ 4.1.3 Sums shall be expressed in both words and numbers, unless noted otherwise on the bid form. In case of discrepancy, the amount entered in words shall govern.

§ 4.1.4 Edits to entries made on paper bid forms must be initialed by the signer of the Bid.

§ 4.1.5 All requested Alternates shall be bid. If no change in the Base Bid is required, enter "No Change" or as required by the bid form.

§ 4.1.6 Where two or more Bids for designated portions of the Work have been requested, the Bidder may, without forfeiture of the bid security, state the Bidder's refusal to accept award of less than the combination of Bids stipulated by the Bidder. The Bidder shall neither make additional stipulations on the bid form nor qualify the Bid in any other manner.

§ 4.1.7 Each copy of the Bid shall state the legal name and legal status of the Bidder. As part of the documentation submitted with the Bid, the Bidder shall provide evidence of its legal authority to perform the Work in the jurisdiction where the Project is located. Each copy of the Bid shall be signed by the person or persons legally authorized to bind the Bidder to a contract. A Bid by a corporation shall further name the state of incorporation and have the corporate seal affixed. A Bid submitted by an agent shall have a current power of attorney attached, certifying the agent's authority to bind the Bidder.

§ 4.1.8 A Bidder shall incur all costs associated with the preparation of its Bid.

§ 4.2 Bid Security

§ 4.2.1 Each Bid shall be accompanied by the following bid security:

(Insert the form and amount of bid security.)

Five percent (5%)

§ 4.2.2 The Bidder pledges to enter into a Contract with the Owner on the terms stated in the Bid and shall, if required, furnish bonds covering the faithful performance of the Contract and payment of all obligations arising thereunder. Should the Bidder refuse to enter into such Contract or fail to furnish such bonds if required, the amount

of the bid security shall be forfeited to the Owner as liquidated damages, not as a penalty. In the event the Owner fails to comply with Section 6.2, the amount of the bid security shall not be forfeited to the Owner.

§ 4.2.3 If a surety bond is required as bid security, it shall be written on AIA Document A310™, Bid Bond, unless otherwise provided in the Bidding Documents. The attorney-in-fact who executes the bond on behalf of the surety shall affix to the bond a certified and current copy of an acceptable power of attorney. The Bidder shall provide surety bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 4.2.4 The Owner will have the right to retain the bid security of Bidders to whom an award is being considered until (a) the Contract has been executed and bonds, if required, have been furnished; (b) the specified time has elapsed so that Bids may be withdrawn; or (c) all Bids have been rejected. However, if no Contract has been awarded or a Bidder has not been notified of the acceptance of its Bid, a Bidder may, beginning days after the opening of Bids, withdraw its Bid and request the return of its bid security.

§ 4.3 Submission of Bids

§ 4.3.1 A Bidder shall submit its Bid as indicated below:
(Indicate how, such as by website, host site/platform, paper copy, or other method Bidders shall submit their Bid.)

Bids shall be delivered in a sealed envelope indicating "Sealed Bid Enclosed", the Bidder's name and address, the name and phone number of the Bidder's contact person, and "Clark County Public Library Northridge Branch." The bids shall be noted for date and time upon receipt. All bids shall be publicly opened and read aloud on March 18, 2024 at 4:00pm during the monthly Clark County Public Library Board meeting. Bids received after 12:00pm March 18, 2024 will be returned unopened.

§ 4.3.2 Paper copies of the Bid, the bid security, and any other documents required to be submitted with the Bid shall be enclosed in a sealed opaque envelope. The envelope shall be addressed to the party receiving the Bids and shall be identified with the Project name, the Bidder's name and address, and, if applicable, the designated portion of the Work for which the Bid is submitted. If the Bid is sent by mail, the sealed envelope shall be enclosed in a separate mailing envelope with the notation "SEALED BID ENCLOSED" on the face thereof.

§ 4.3.3 Bids shall be submitted by the date and time and at the place indicated in the invitation to bid. Bids submitted after the date and time for receipt of Bids, or at an incorrect place, will not be accepted.

§ 4.3.4 The Bidder shall assume full responsibility for timely delivery at the location designated for receipt of Bids.

§ 4.3.5 A Bid submitted by any method other than as provided in this Section 4.3 will not be accepted.

§ 4.4 Modification or Withdrawal of Bid

§ 4.4.1 Prior to the date and time designated for receipt of Bids, a Bidder may submit a new Bid to replace a Bid previously submitted, or withdraw its Bid entirely, by notice to the party designated to receive the Bids. Such notice shall be received and duly recorded by the receiving party on or before the date and time set for receipt of Bids. The receiving party shall verify that replaced or withdrawn Bids are removed from the other submitted Bids and not considered. Notice of submission of a replacement Bid or withdrawal of a Bid shall be worded so as not to reveal the amount of the original Bid.

§ 4.4.2 Withdrawn Bids may be resubmitted up to the date and time designated for the receipt of Bids in the same format as that established in Section 4.3, provided they fully conform with these Instructions to Bidders. Bid security shall be in an amount sufficient for the Bid as resubmitted.

§ 4.4.3 After the date and time designated for receipt of Bids, a Bidder who discovers that it made a clerical error in its Bid shall notify the Architect of such error within two days, or pursuant to a timeframe specified by the law of the jurisdiction where the Project is located, requesting withdrawal of its Bid. Upon providing evidence of such error to the reasonable satisfaction of the Architect, the Bid shall be withdrawn and not resubmitted. If a Bid is withdrawn pursuant to this Section 4.4.3, the bid security will be attended to as follows:
(State the terms and conditions, such as Bid rank, for returning or retaining the bid security.)

Bid security shall be returned/ voided if bidder is not the lowest bidder.

ARTICLE 5 CONSIDERATION OF BIDS

§ 5.1 Opening of Bids

If stipulated in an advertisement or invitation to bid, or when otherwise required by law, Bids properly identified and received within the specified time limits will be publicly opened and read aloud. A summary of the Bids may be made available to Bidders.

§ 5.2 Rejection of Bids

Unless otherwise prohibited by law, the Owner shall have the right to reject any or all Bids.

§ 5.3 Acceptance of Bid (Award)

§ 5.3.1 It is the intent of the Owner to award a Contract to the lowest responsive and responsible Bidder, provided the Bid has been submitted in accordance with the requirements of the Bidding Documents. Unless otherwise prohibited by law, the Owner shall have the right to waive informalities and irregularities in a Bid received and to accept the Bid which, in the Owner's judgment, is in the Owner's best interests.

§ 5.3.2 Unless otherwise prohibited by law, the Owner shall have the right to accept Alternates in any order or combination, unless otherwise specifically provided in the Bidding Documents, and to determine the lowest responsive and responsible Bidder on the basis of the sum of the Base Bid and Alternates accepted.

ARTICLE 6 POST-BID INFORMATION

§ 6.1 Contractor's Qualification Statement

Bidders to whom award of a Contract is under consideration shall submit to the Architect, upon request and within the timeframe specified by the Architect, a properly executed AIA Document A305™, Contractor's Qualification Statement, unless such a Statement has been previously required and submitted for this Bid.

§ 6.2 Owner's Financial Capability

A Bidder to whom award of a Contract is under consideration may request in writing, fourteen days prior to the expiration of the time for withdrawal of Bids, that the Owner furnish to the Bidder reasonable evidence that financial arrangements have been made to fulfill the Owner's obligations under the Contract. The Owner shall then furnish such reasonable evidence to the Bidder no later than seven days prior to the expiration of the time for withdrawal of Bids. Unless such reasonable evidence is furnished within the allotted time, the Bidder will not be required to execute the Agreement between the Owner and Contractor.

§ 6.3 Submittals

§ 6.3.1 After notification of selection for the award of the Contract, the Bidder shall, as soon as practicable or as stipulated in the Bidding Documents, submit in writing to the Owner through the Architect:

.1 a designation of the Work to be performed with the Bidder's own forces;

.2 names of the principal products and systems proposed for the Work and the manufacturers and suppliers of each; and

.3 names of persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for the principal portions of the Work.

§ 6.3.2 The Bidder will be required to establish to the satisfaction of the Architect and Owner the reliability and responsibility of the persons or entities proposed to furnish and perform the Work described in the Bidding Documents.

§ 6.3.3 Prior to the execution of the Contract, the Architect will notify the Bidder if either the Owner or Architect, after due investigation, has reasonable objection to a person or entity proposed by the Bidder. If the Owner or Architect has reasonable objection to a proposed person or entity, the Bidder may, at the Bidder's option, withdraw the Bid or submit an acceptable substitute person or entity. The Bidder may also submit any required adjustment in the Base Bid or Alternate Bid to account for the difference in cost occasioned by such substitution. The Owner may accept the adjusted bid price or disqualify the Bidder. In the event of either withdrawal or disqualification, bid security will not be forfeited.

§ 6.3.4 Persons and entities proposed by the Bidder and to whom the Owner and Architect have made no reasonable objection must be used on the Work for which they were proposed and shall not be changed except with the written consent of the Owner and Architect.

ARTICLE 7 PERFORMANCE BOND AND PAYMENT BOND

§ 7.1 Bond Requirements

§ 7.1.1 If stipulated in the Bidding Documents, the Bidder shall furnish bonds covering the faithful performance of the Contract and payment of all obligations arising thereunder.

§ 7.1.2 If the furnishing of such bonds is stipulated in the Bidding Documents, the cost shall be included in the Bid. If the furnishing of such bonds is required after receipt of bids and before execution of the Contract, the cost of such bonds shall be added to the Bid in determining the Contract Sum.

§ 7.1.3 The Bidder shall provide surety bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 7.1.4 Unless otherwise indicated below, the Penal Sum of the Payment and Performance Bonds shall be the amount of the Contract Sum.
(If Payment or Performance Bonds are to be in an amount other than 100% of the Contract Sum, indicate the dollar amount or percentage of the Contract Sum.)

§ 7.2 Time of Delivery and Form of Bonds

§ 7.2.1 The Bidder shall deliver the required bonds to the Owner not later than three days following the date of execution of the Contract. If the Work is to commence sooner in response to a letter of intent, the Bidder shall, prior to commencement of the Work, submit evidence satisfactory to the Owner that such bonds will be furnished and delivered in accordance with this Section 7.2.1.

§ 7.2.2 Unless otherwise provided, the bonds shall be written on AIA Document A312, Performance Bond and Payment Bond.

§ 7.2.3 The bonds shall be dated on or after the date of the Contract.

§ 7.2.4 The Bidder shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix to the bond a certified and current copy of the power of attorney.

ARTICLE 8 ENUMERATION OF THE PROPOSED CONTRACT DOCUMENTS

§ 8.1 Copies of the proposed Contract Documents have been made available to the Bidder and consist of the following documents:

.1 AIA Document A101™–2017, Standard Form of Agreement Between Owner and Contractor, unless otherwise stated below.
(Insert the complete AIA Document number, including year, and Document title.)

.2 AIA Document A101™–2017, Exhibit A, Insurance and Bonds, unless otherwise stated below.
(Insert the complete AIA Document number, including year, and Document title.)

.3 AIA Document A201™–2017, General Conditions of the Contract for Construction, unless otherwise stated below.
(Insert the complete AIA Document number, including year, and Document title.)

(Paragraphs Deleted)

.5 Drawings

The Construction Drawings prepared by Architect, dated 2/23/2024, and any and all addenda thereto, and as hereafter modified or supplemented, all of which are incorporated herein and made a part of this Agreement by reference, and as hereafter modified or supplemented, including any and all addenda thereto, notes, memoranda and/or details included thereon or associated therewith.

(Table Deleted)

.6 Specifications

The Specifications prepared by Architect, dated _, and any and all addenda thereto, and as hereafter modified or supplemented, all of which are incorporated herein and made a part of this Agreement by reference, and as hereafter modified or supplemented, including any and all addenda thereto, notes, memoranda and/or details included thereon or associated therewith.

(Table Deleted)

.7 Addenda:

Number	Date	Pages

.8

(Paragraphs Deleted)

(Paragraph Deleted)

(Table Deleted)

(Paragraph Deleted)

(Table Deleted)

Additions and Deletions Report for
AIA® Document A701® – 2018

This Additions and Deletions Report, as defined on page 1 of the associated document, reproduces below all text the author has added to the standard form AIA document in order to complete it, as well as any text the author may have added to or deleted from the original AIA text. Added text is shown underlined. Deleted text is indicated with a horizontal line through the original AIA text.

Note: This Additions and Deletions Report is provided for information purposes only and is not incorporated into or constitute any part of the associated AIA document. This Additions and Deletions Report and its associated document were generated simultaneously by AIA software at 11:30:45 ET on 02/23/2024.

PAGE 1

Clark County Public Library Northridge Branch
Moorefield Road
Springfield, Ohio 45503

...

Clark County Public Library
201 South Fountain Avenue
Telephone Number: Springfield, Ohio 45506

...

Luminaut, Inc.
1100 Sycamore Street
Telephone Number: Suite 200
Fax Number: Cincinnati, Ohio 45202

PAGE 2

Dayton Builders Exchange www.bxohio.com
Dodge Construction Network www.construction.com

PAGE 3

Erin Jennings, AIA,
ejennings@luminaut.com

PAGE 4

Through online plan rooms hosting drawings.

...

Five percent (5%)

PAGE 5

Bids shall be delivered in a sealed envelope indicating "Sealed Bid Enclosed", the Bidder's name and address, the name and phone number of the Bidder's contact person, and "Clark County Public Library Northridge Branch." The bids shall be noted for date and time upon receipt. All bids shall be publicly opened and read aloud on March 18,

2024 at 4:00pm during the monthly Clark County Public Library Board meeting. Bids received after 12:00pm March 18, 2024 will be returned unopened.

PAGE 6

Bid security shall be returned/ voided if bidder is not the lowest bidder.

PAGE 8

~~.4 AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, dated as indicated below:~~

...

~~*(Insert the date of the E203–2013.)*~~

...

The Construction Drawings prepared by Architect, dated 2/23/2024, and any and all addenda thereto, and as hereafter modified or supplemented, all of which are incorporated herein and made a part of this Agreement by reference, and as hereafter modified or supplemented, including any and all addenda thereto, notes, memoranda and/or details included thereon or associated therewith.

...

~~Number~~ ~~Title~~ ~~Date~~

...

The Specifications prepared by Architect, dated _, and any and all addenda thereto, and as hereafter modified or supplemented, all of which are incorporated herein and made a part of this Agreement by reference, and as hereafter modified or supplemented, including any and all addenda thereto, notes, memoranda and/or details included thereon or associated therewith.

...

~~Section~~ ~~Title~~ ~~Date~~ ~~Pages~~

...

.8 ~~Other Exhibits:~~

...

~~*(Check all boxes that apply and include appropriate information identifying the exhibit where required.)*~~

...

~~[ ] AIA Document E204™–2017, Sustainable Projects Exhibit, dated as indicated below:~~

...

~~*(Insert the date of the E204-2017.)*~~

...

~~[ ] The Sustainability Plan:~~

...

~~Title~~	~~Date~~	~~Pages~~

...

~~[ ] Supplementary and other Conditions of the Contract:~~

...

~~Document~~	~~Title~~	~~Date~~	~~Pages~~

PAGE Error! Bookmark not defined.

~~.9 Other documents listed below:~~

...

~~*(List here any additional documents that are intended to form part of the Proposed Contract Documents.)*~~

Certification of Document's Authenticity

AIA® Document D401™ – 2003

I, Eric J. Rowland, AIA, hereby certify, to the best of my knowledge, information and belief, that I created the attached final document simultaneously with its associated Additions and Deletions Report and this certification at 11:30:45 ET on 02/23/2024 under Order No. 4104250075 from AIA Contract Documents software and that in preparing the attached final document I made no changes to the original text of AIA® Document A701™ - 2018, Instructions to Bidders, other than those additions and deletions shown in the associated Additions and Deletions Report.

_____

(Signed)

_____

(Title)

_____

(Dated)

This form shall be utilized by all Bidders. Except as otherwise specifically provided, all Parts shall be fully and accurately filled-in, completed and notarized. Type or print all required information.

Project: Clark County Public Library
New Northridge Branch

Bid Date: March 18, 2024

Owner: Clark County Public Library
201 South Fountain Avenue
Springfield, Ohio 45506

PART 1
BIDDER INFORMATION

Bidder:_____

Agent of Bidder (if applicable):_____

Email address:_____

Phone Number:_____

Former Business Names of Bidder:_____

Bidder is a/an [mark all as appropriate]:

___ Individual __ Partnership ___ Corporation

___ Foreign (Out of State) Corporation

___ Joint Venture

___ MBE __ WBE ___ VBE ___ DOBE

Other:_____

Business Entity Name: _____

Address: _____

☐ Bid Security in the amount of 5% of the total bid amount, is enclosed.

PART 2
BID AND COMPLETION TIME

The undersigned Bidder, with complete understanding of the requirements of the bidding documents, proposes to furnish all necessary labor, machinery, tools, apparatus, materials, equipment, service and other necessary supplies, and to perform and fulfill all obligations incident thereto in strict accordance with and within the time(s) provided by the terms and conditions of the Contract Documents for the above described Work and Project, including any and all addenda thereto, for the total **LUMP SUM PRICE** of:

_____ $_____

(Amount in words) (Numerals)

By submitting a bid, the Bidder agrees the Bid shall be valid for sixty (60) days from Bid Opening.

COMPLETION TIME:

I/we will substantially complete the work under this contract within _____ calendar days from the date the Project Site is made available for work assuming that we are not delayed by work stoppages or other causes beyond our control.

PART 3
ALLOWANCES

Allowances are identified under Section 01 21 00 – ALLOWANCES.

The Bidder shall include in its Base Bid cost the value for each of the Following Allowances:

Landscaping Allowance: $20,000.00

Hot Air Balloon Allowance: $75,000.00

PART 4
CONTRACT DOCUMENTS AND ADDENDA

The Bidder agrees to be bound by the terms and provisions of all Contract Documents as defined in the General Conditions and incorporates such Contract Documents herein by reference. I/We have received and thoroughly reviewed the bidding documents for the above project and have thoroughly examined the Project site. Pursuant to notices given the undersigned will provide all labor and material for the complete construction of New Northridge Branch in accordance with the Bidding Documents dated December 20, 2023.

I/We have also received and reviewed Addenda listed below and have included their provisions in my/our bid.

Addenda Number Received: _____

PART 5
EXCEPTIONS

The Bidder shall fully state each exception taken to the Specifications or other Bidding Documents. The Bidder is cautioned that any exception taken by the Bidder and deemed by Clark County Public Library to be a material qualification or variance from the terms of the Bidding Documents may result in their Bid being deemed as non-responsive and rejected as such.

Exceptions:

_____
_____
_____
_____
_____
_____
_____

PART 6
COMPLIANCE WITH APPLICABLE LAWS

By submitting a Bid for Work on the Project, the Bidder acknowledges that it is in compliance with applicable federal, state, and local laws and regulations, including, but not limited to, the following:

Equal Employment Opportunity/Nondiscrimination: The Bidder agrees that if it is awarded a contract that in the hiring of employees for performance of work under the Contract or any subcontract, neither it nor any subcontractor, or any person acting on its behalf or its subcontractor's behalf, by reason of race, creed, sex, disability, or color as defined in Section 4112.01 of the Ohio Revised Code, shall discriminate against any citizen of the state in the employment of labor or workers who are qualified and available to perform work to which the employment relates. The Bidder further agrees that neither it nor any subcontractor or any person on its behalf or on behalf of any subcontractor, in any manner, shall discriminate against or intimidate any employees hired for the performance of the work under the Contract on account of race, creed, sex, disability, or color as defined in Section 4112.01 of the Ohio Revised Code.

Ethics Laws: The Bidder represents that it is familiar with all applicable ethics law requirements, including without limitation Sections 102.04 and 3517.13 of the Ohio Revised Code, and certifies that it is in compliance with such requirements.

PART 7
LEGAL VIOLATIONS

The Bidder shall provide any determinations by a court or government agency for violations of federal, state, or local laws including but not limited to violations of contracting or antitrust laws, tax or licensing laws, environmental laws, the Occupational and Safety and Health Act ("OSHA"), or federal Davis-Bacon and related acts.

Have you had any determinations by a court or government agency for violations of federal, state, or local laws including but not limited to violations of contracting or antitrust laws, tax or licensing laws, environmental laws, the Occupational and Safety and Health Act ("OSHA"), or federal Davis-Bacon and related acts?

Check one: Yes_____ No _____

If you answered "yes" to the question above, list each determination along with the year it occurred:

_____

PART 8
TAX DEFICIENCIES

The Bidder shall provide a statement listing and describing any federal, state, or local tax liens or tax delinquencies owed to any federal, state, or local taxing body in the last 5 years. Answer the following questions to provide the statement regarding your tax deficiencies.

Do you have now or have had in the last 5 years any federal, state, or local tax liens or tax delinquencies owed to any federal, state, or local taxing body?

Check one: Yes_____ No _____

If you answered "yes" to the question above, list each lien or delinquency, along with the year it occurred, and whether it has been resolved:

_____

PART 9
NON COLLUSION AFFIDAVIT

The undersigned, on behalf of the Bidder, being first duly sworn, deposes and states that the Bidder has not, nor has any other member, representative, employee or agent of the Bidder, entered into any combination, collusion or agreement with any person relative to the Bid by anyone at such letting, to prevent any person from submitting a Bid, or to induce anyone to refrain from submitting a Bid.

The undersigned further deposes and states that this Bid is made without reference to any other Bid and without any agreement, understanding or combination with any other person referring to such Bid.

The undersigned further deposes and states that no person, firm or entity has or will receive directly or indirectly, any rebate, fee, gift, commission or thing of value on account of such Bid.

Bidder: _____

By (Signature): _____

(Printed Name and Title): _____

(Important – Notary Signature and Seal Required in the Space Below)

STATE OF _____

Seal:

COUNTY OF _____

Subscribed and sworn to before me this _____day of _____20___.

My commission expires: _____ (Signed) _____

Residing in _____ County, State of _____

PART 10
OATH AND ATTESTATION

I,_____, as authorized agent and/or representative of the Bidder,
, being first deposed upon my oath, do hereby certify and attest, swear and/or affirm, subject to penalties for perjury, that all of the foregoing information and statements contained here are true, complete, and accurate.

By (Signature): _____

(Important – Notary Signature and Seal Required in the Space Below)

STATE OF _____

Seal:

COUNTY OF _____

Subscribed and sworn to before me this _____day of _____20___.

My commission expires: _____ (Signed) _____

Residing in _____ County, State of _____

SECTION 00 04 10
SCHEDULE OF SUBCONTRACTORS SUPPLIES AND MANUFACTURERS

PART 1 GENERAL

1.1 DESCRIPTION

A. The Architect shall request selected Bidders to furnish, within 72 hours after receipt of Bids, completed versions of the attached Schedule of Materials and Sub-contractors.

B. The Owner and Architect shall have the right to choose the Manufacturer for any particular item where the bidder either fails to list a Manufacturer or lists more than one for the item in question.

C. It is intended that this list will show manufacturer and/or supplier of all major items of work that will be subcontracted and to whom.

D. After submission of this list by the Bidder and after approval of same by the Architect, it shall not be changed unless written approval of said change is authorized by the Architect, and unless said change is beneficial to the Owner.

E. The Architect reserves the right to reject any submission of materials, or manufacturer that does not, in their opinion, meet the requirements of the drawings and specifications unless such materials, work or subcontract was requested by Bidder prior to Bidding and approved by Addendum.

F. Submission does not constitute approval. Materials and Manufacturers are subject to provisions of General Conditions and must be formally approved by Architect.

THIS BID IS FROM THE FOLLOWING CONTRACTOR:

_____

DESCRIPTION	SUBCONTRACTOR AND/OR SUPPLIER	PRODUCT AND/OR MANUFACTURER

THIS BID IS BASED ON USING THE FOLLOWING MECHANICAL SUB-CONTRACTOR:

_____

DESCRIPTION	SUBCONTRACTOR AND/OR SUPPLIER	PRODUCT AND/OR MANUFACTURER

THIS BID IS BASED ON USING THE FOLLOWING ELECTRICAL SUB-CONTRACTOR:

_____

DESCRIPTION	SUBCONTRACTOR AND/OR SUPPLIER	PRODUCT AND/OR MANUFACTURER

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 04 10

SECTION 00 05 00
STANDARD FORM OF AGREEMENT

PART 1 GENERAL

1.1 CONTRACT FORM

A. The Contract upon which the agreement for construction of this Project will be based is AIA Document A101 - 2017, Agreement Between Owner and Contractor (the “Agreement”), as modified by counsel for the Owner for use on this project.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 05 00

SECTION 00 06 00
INSURANCE AND BONDS

PART 1 GENERAL

1.1 EXHIBIT A, INSURANCE AND BONDS

A. The supplement to the contract upon which the agreement for construction of this Project will be based is Exhibit A, AIA Document A101 - 2017, Insurance and Bonds, as modified by counsel for the Owner for use on this project.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 06 00

SECTION 00 07 00
GENERAL CONDITIONS

GENERAL

1.1 CONTRACT DOCUMENT PRETAINING TO GENERAL CONDITIONS

A. The General Conditions for this project are the AIA Document A201, General Conditions of the Contract for Construction, as modified by counsel for Owner (the “General Conditions”).

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 07 00

SECTION 01 01 00
SUMMARY OF WORK

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

A. All applicable requirements of the Project Manual, including Bidding Requirements, General and Special Conditions, and General Requirements, apply to each section of the Specifications.
   1. Project Location: Clark County Public Library Northridge Branch - Moorefield Road, Springfield, Ohio 45505.

B. Work consists of but is not limited to furnishing all labor, tools, materials, transportation and equipment necessary for making all repairs and installing all products as indicated in the Contract Documents.

C. Contractor shall comply with all applicable laws, ordinances, rules, regulations and lawful orders of any public authority having jurisdiction for the safety of persons or property or to protect them from injury or loss. He shall erect and maintain, as required by existing conditions and progress of work, all reasonable safeguards for safety and protection including posting danger signs and other warnings against hazards. All requirements of the Occupational Safety and Health Act are to be followed explicitly and are the responsibility of the contractor.

D. Contractor shall secure and pay for, as necessary for the proper execution of the Work, Permits (including Building Permits), Government Fees, and Licenses.

E. Contractor shall give required notices and comply with codes, ordinances, or other legal requirements of authorities which bear on performance of the Work.

1.2 INSPECTION OF SITE

A. A Pre-bid Meeting date, time and locations is scheduled as identified in the Notice to Bidders.

B. All prospective bidders are required to visit the Project site and to examine existing conditions and make note of any conditions, which may pertain to his class of work. Failure to do so will not relieve bidder of responsibility in connection with his work.

1.3 CONTRACTOR'S USE OF PREMISES

1.4 TEMPORARY FACILITIES:

1. Refer to SECTION 01 50 00, Temporary Facilities and Controls.
2. Contractor is cautioned about excessive use or overloading of circuits and panels.
3. Contractor shall provide all necessary traffic control barriers and directing personnel for the performance of work.

B. Contract Limits:
   1. Contract limits shall be restricted to those parts which are shown on Contract Documents.

1.5 PROTECTION OF PROPERTY:

1.6 CONTRACTOR SHALL PROVIDE ADEQUATE PROTECTION FOR PORTIONS OF EXISTINGBUILDING, PARKED VEHICLES AND SURROUNDING PAVEMENTS, LAWNS AND LANDSCAPING. CONTRACTOR SHALL ASSUME ALL COSTS RESULTING FROM ANY DAMAGES.

1. If applicable, maintain exit access to stairs and exit egress from building(s) during construction activities. Do not block exit(s) without notifying Owner's Representative.
2. Contractor shall photographically document pre-construction conditions of all conditions. Photographs shall be in digital form and shall be furnished to Owner on request.
3. Contractor shall secure any conduit support relocated or adversely affected by the construction.

1.7 PARKING AND STORAGE

A. Parking areas for use of contractor and his employees, if any, shall be described at the Pre-bid Meeting.

B. Contractor's vehicles shall be plainly marked on sides or with plaque at least 8.5" x 11" on dash board.

C. Storage and staging areas, including dumpster locations, on site shall be reviewed and approved by the Owner. While the Owner's Representative may designate storage areas for temporary storage of materials, the Owner cannot guarantee the security of items placed there by the Contractor.

D. All construction debris shall be removed from the work site each day. Do not allow debris to accumulate outside dumpster for more than 24 hours before removal and disposal.

1.8 OWNER OCCUPANCY

A. Coordinate use of premises under direction of Owner's Representative.

B. Do not unreasonably encumber site with materials or equipment.

C. Assume full responsibility for protection and safekeeping of products stored at work site.

D. Excessive noise from construction activities will not be allowed in or around occupied buildings. Schedule noise producing activities for times when building occupants will not be disturbed, or take measures to reduce noise to acceptable levels when requested by the Owner's Representative.

E. Contractor shall take all precautions to prevent damage and injury to the facility, and equipment, vehicles and people using the facility. Contractor shall be responsible for all damage or injuries at no additional cost to the Owner.

1.9 WORK SEQUENCE

A. Prior to starting work, the successful contractor shall submit a complete schedule that designates areas of the building closed for construction and durations of closures for the Owner's Representative review and approval. No work shall commence without the approval of the Owner.

1.10 FINAL CLEAN-UP

A. Remove all debris, rubbish, broken glass, and unused materials. Repair all damaged surfaces.

1.11 CLOSE-OUT

A. The Architect, Contractor, and Owner's Representative shall make a joint final inspection. Contractor to deliver a complete release of all liens up to any retained amount and clarify that all bills for labor and materials or services have been paid.

1.12 PROTECTION

A. Protect existing structure, roads, sidewalks, paving and curbs which are to remain.

B. Repair damage to satisfaction of Owner's Representative.

1.13 SCHEDULING

A. Follow schedule of Work as submitted on approved Schedule.

B. Inform Owner immediately of any delays in following the schedule of Work.

1.14 GUARANTEE

A. Provide minimum two (2) year labor and materials guarantee.

B. Provide additional warranties as specified.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 01 00

SECTION 010900 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

B. Related Sections:

1. Division 22 Section "COMMISSIONING OF PLUMBING SYSTEMS" for commissioning process activities for plumbing systems, assemblies, equipment, and components.

2. Division 23 Section "COMMISSIONING OF HVAC SYSTEMS" for commissioning process activities for HVAC&R systems, assemblies, equipment, and components.

3. Division 26 Section "COMMISSIONING OF ELECTRICAL SYSTEMS" for commissioning process activities for electrical systems, assemblies, equipment, and components.

4. Section 070523 - Pressure Testing an Air Barrier System for Air Tightness

1.2 DEFINITIONS

A. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

C. CxA: Commissioning Authority.

D. OPR: Owner's Project Requirements. 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.

E. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.

2. Representatives of the facility user and operation and maintenance personnel.

3. Architect and engineering design professionals.

1.4 OWNER'S RESPONSIBILITIES

A. Provide the OPR documentation to the CxA and Contractor for information and use. CxA will assist owner in the creation of OPR if needed.

B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

C. Provide the BoD documentation, prepared by Architect and approved by Owner, to the CxA and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.

2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.

3. Attend commissioning team meetings held on a monthly basis until 20% of equipment has been started or is ready to start. Meetings will be bi-weekly from that point on.

4. Integrate and coordinate commissioning process activities with construction schedule.

5. Complete electronic construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.

6. Review and accept commissioning process test procedures provided by the Commissioning Authority.

7. Complete commissioning process test procedures.

1.6 CxA'S RESPONSIBILITIES

A. Organize and lead the commissioning team.

B. Provide commissioning plan.

C. Convene commissioning team meetings.

D. Provide Project-specific construction checklists and commissioning process test procedures.

E. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log.

F. Prepare and maintain the Issues Log.

G. Prepare and maintain completed construction checklist log.

H. Witness systems, assemblies, equipment, and component startup.

I. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

END OF SECTION 010900

SECTION 01 21 00
ALLOWANCES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements governing allowances.
   1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements.

B. Types of allowances include the following:
   1. Lump-sum allowances.

1.3 SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders and Requests for Proposals.

B. Submit invoices or delivery slips to show actual quantities of materials removed and delivered to the site for use in fulfillment of each allowance. Quantities shall be confirmed by Owner's Testing Agency.

C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.4 LUMP-SUM ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner under allowance and shall include taxes, freight, and delivery to Project site.

B. Allowances as described in the "Schedule of Allowances" apply only to work for unforeseen conditions, and not to work required by the Contract Documents.

C. Owner shall approve the use of the portion of the allowance requested. Funds not used shall be returned to the Owner through a Change Order.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.2 SCHEDULE OF ALLOWANCES

A. Landscaping Allowance: Twenty Thousand Dollars and Zero Cents ($20,000.00)

B. Hot Air Balloon Allowance: Seventy-Five Thousand Dollars and Zero Cents ($75,000.00)

END OF SECTION 01 21 00

SECTION 01 22 00
UNIT PRICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements governing unit prices.

1.3 DEFINITIONS

A. Unit price is an amount proposed by the Bidder, stated by the Contractor, a price per unit of measurement for materials, equipment, or services added to or deducted from the Contract Sum by appropriate modification, if the estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices.

C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

E. Unit Prices apply only to changes in the Work requested through a Construction Change Order or Change Directive and not for work to be included in the Base Bid or alternates.

PART 2 PRODUCTS

2.1 NOT USED.

PART 3 EXECUTION

3.1 SCHEDULE OF UNIT PRICES

A. No schedule of Unit Prices are required for bidding.

B. Section is retained for future use, if required for items encountered during construction.

END OF SECTION 01 22 00

SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.1 REQUIREMENTS

A. The products, materials, and equipment of manufacturers referred to in the Bidding Documents are intended to establish the standard of quality and design required by the Architect and the Owner. Products, materials, and equipment of manufacturers other than those specified, may be used, if equivalent and approved by the Architect.

B. The Architect will be the sole judge of equivalency of proposed substitute products, materials, and equipment.

C. If the Bidder or Contractor desires to use a substitute item, they shall make application to the Architect in writing, stating and fully identifying the proposed substitute, cost changes (if any) and submit substantiating data, samples, brochures, etc., of item proposed. It is the Contractor's responsibility to provide sufficient evidence by tests or other means to support any request for approval of substitutions.

D. Prior to proposing any substitute item, the Contractor shall be satisfied that the item proposed is, in fact, equal to that specified, that it will fit into the space allocated, that it affords comparable ease of operation, maintenance and service, that its appearance, longevity, and suitability for the climate and use are comparable to that specified, and that the substitution is in the Owner's interest.

E. The burden of proof that a proposed substitution is equal to a specified item shall be upon the Contractor, who shall support request with sufficient test data and other means to permit the Architect to make a fair and equitable decision on the merits of the proposal. Any item by a manufacturer other than those cited in the Contract Documents, or of brand name or model number, or of generic species, other than those cited in the Contract Documents, will be considered a substitution.

F. Materials and methods proposed as substitutions for specified items shall be supported by certification of their acceptance for use by any authority, person or persons having jurisdiction over the use of specified material or method.

G. Acceptance of substitutions shall not relieve the Contractor from responsibility for compliance with the requirements of the Contract Documents. The Contractor shall be responsible at their own expense for any changes in other parts of the work of their contract or the work of other Contractors caused by their substitutions, including cost of all design and redesign services related thereto, incurred by the Architect.

H. The contract completion time shall not be extended by any circumstances resulting from proposed substitution, nor shall the Contractor be entitled to any compensation for any delay caused thereby or related thereto.

I. All costs for the evaluation of proposed substitutions, whether approved or not, shall be borne by the Bidder or Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

A. Bidder shall use CSI Form 15.1C 2013 Substitution Request for their written request.

END OF SECTION 01 25 00

SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General administrative requirements.

B. Electronic document submittal service.

C. Preconstruction meeting.

D. Site mobilization meeting.

E. Progress meetings.

F. Construction progress schedule.

G. Progress photographs.

H. Coordination drawings.

I. Submittals for review, information, and project closeout.

J. Number of copies of submittals.
   1. Requests for Interpretation (RFI) procedures.

K. Submittal procedures.

1.2 RELATED REQUIREMENTS

A. Section 01 60 00 - Product Requirements: General product requirements.

B. Section 01 71 00 Project Closeout: Project record documents; operation and maintenance data; warranties and bonds.

1.3 GENERAL ADMINISTRATIVE REQUIREMENTS

A. Comply with requirements of Section 01 71 00 Project Closeout 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.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 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. Project Closeout: Contractor will determine when to terminate the service for the project and is responsible for obtaining archive copies of files for Owner.

3.2 PRECONSTRUCTION MEETING

A. Schedule 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. Submission of initial Submittal schedule.
   6. Designation of personnel representing the parties to Contract and Architect.

7. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
8. Scheduling.

D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.3 SITE MOBILIZATION MEETING

A. Schedule meeting at the Project site prior to Contractor occupancy.

B. Attendance Required:
1. Contractor.
2. Owner.
3. Architect.
4. Contractor's superintendent.
5. Major subcontractors.

C. Agenda:
1. Use of premises by Owner and Contractor.
2. Owner's requirements.
3. Construction facilities and controls provided by Owner.
4. Temporary utilities provided by Owner.
5. Survey and building layout.
6. Security and housekeeping procedures.
7. Schedules.
8. Application for payment procedures.
9. Procedures for testing.
10. Procedures for maintaining record documents.
11. Requirements for start-up of equipment.
12. 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.

3.4 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the work at minimum bi-monthly intervals.

B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

C. Attendance Required:
1. Contractor.
2. Owner.
3. Architect.
4. Contractor's superintendent.
5. Major subcontractors.

D. 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. Review of RFIs log and status of responses.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Maintenance of quality and work standards.
12. Effect of proposed changes on progress schedule and coordination.
13. Other business relating to 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.

3.5 CONSTRUCTION PROGRESS SCHEDULE

A. Within 5 days after date of the Agreement, submit preliminary schedule.
   1. If preliminary schedule requires revision after review, submit revised schedule within 5 days.

B. Within 10 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
   1. Within 5 days after joint review, submit complete schedule.
   2. Submit updated schedule with each Application for Payment.

3.6 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 site and construction throughout progress of work produced by photographer, acceptable to Architect.

D. In addition to periodic, recurring views, take photographs of each of the following events:
   1. In-slab systems in progress and before pouring back concrete.
   2. Structural framing in progress and upon completion.
   3. Enclosure of building, upon completion.
   4. Photos prior to in-wall and above ceiling inspections by Authorities Having Jurisdiction.
   5. Major milestones in interior buildout.
   6. Final completion, minimum of ten (10) photos.

E. Digital Photographs: 24 bit color, minimum resolution of 1024 by 768, in JPG format; provide files unaltered by photo editing software.
   1. PDF File: Assemble all photos into printable pages in PDF format, with 2 to 3 photos per page, each photo labeled with file name; one PDF file per submittal.
      a. Option to provide photos digitally through online construction administration service. Include copies of photos with final project closeout.

3.7 COORDINATION DRAWINGS

3.8 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.
   4. Combine RFI and its attachments into a single electronic file. PDF format is preferred.

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. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
   2. 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)
      c. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
      d. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).
   3. 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.

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 business days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 3:00 PM 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.

3.9 SUBMITTALS

A. Submit to Architect for review a schedule for submittals in tabular format.
1. Coordinate with Contractor's construction schedule and schedule of values.
2. Format schedule to allow tracking of status of submittals throughout duration of construction.
3. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
4. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.
a. For assemblies, equipment, systems comprised of multiple components and/or requiring detailed coordination with other work, allow for additional time to make corrections or revisions to initial submittals, and time for their review.

B. Refer to section 01 33 00 Submittals for submittal requirements.

3.10 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.
   a. Color selections will not be reviewed or selected digitally or from printed source material. Ensure physical samples are included for all color selections.

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.

3.11 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.

3.12 SUBMITTAL PROCEDURES

A. General Requirements:
   1. Use a separate transmittal for each item.
   2. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
   3. 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.
   4. Schedule submittals to expedite the Project, and coordinate submission of related items.
   5. When revised for resubmission, identify all changes made since previous submission.
   6. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
   7. 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.
   8. Submittals not requested will be recognized, and will be returned "Not Reviewed",

END OF SECTION 01 30 00

SECTION 01 31 19
MEETINGS AND SCHEDULES

PART 1 GENERAL

1.1 MEETING PROCEDURES

A. The Contractor shall schedule and administer a pre-construction meeting, periodic progress meetings, and specially called meetings throughout the progress of the work. The Contractor's responsibilities shall include the following:
   1. Prepare agenda for meetings.
   2. Distribute written notice of each meeting seven (7) days in advance of the meeting date.
   3. Make physical arrangements for the meetings.
   4. Preside at meetings.
   5. Record the meetings including all significant proceedings and decisions.
   6. Reproduce and distribute copies of the minutes within five (5) days after the meeting.
      a. To all participants in the meeting.
      b. To all parties affected by decisions made at the meeting.
      c. Furnish one copy of the minutes to the Design Professional.
      d. Furnish one copy of the minutes to the Owner.

B. Representatives of the Contractor, sub-contractor, and suppliers attending the meetings shall be qualified and authorized to act on behalf of the entity each represents.

C. The Contractor shall administer meetings to ascertain that the work is expedited consistent with the Contract Documents and the Construction Schedule.

D. Smoking and chewing tobacco at the meetings are prohibited.

1.2 PRE-AWARD/PRE-CONSTRUCTION MEETING

A. Prior to award of Contract, the Bidder may be required to attend a pre-award meeting with the Architect and the Owner. The Bidder's principal subcontractors may be required to attend. The pre-award meeting shall consist of, but not be limited to, the following agenda:
   1. Coordination with the building contractors.
   2. Designation of responsible personnel.
   3. Labor availability.
   4. Material and equipment availability and deliveries.
   5. Subcontractors and material suppliers.
   6. Bid breakdown.
   7. Construction scheduling information.
   8. Critical work sequencing and timing.
   9. Procedures for shop drawings, product data, and samples.
   10. Procedures for changes in work.
   11. Progress meetings, schedule and quality control.
   12. Temporary facilities and use of site.
   13. Clean-up, safety, and security responsibilities.
   14. Insurance certification.
   15. Other general requirements and/or special conditions.

1.3 PROGRESS MEETINGS

A. Progress meetings shall be held at a maximum of two (2) week intervals throughout the Construction process. The time and place for the meetings will be agreed to by the Owner and the Architect. Contractors actively on site or those anticipated to be required on site within two weeks shall be required to attend. Agenda shall consist of but not be limited to:
   1. Review of work completed in previous two weeks
   2. Review of minutes of previous meeting
   3. Discussion of work anticipated in following two weeks including offsite fabrication, storage, and delivery
   4. Review of submittals, submittal logs, and record drawings
   5. Coordination issues among Owner, Architect, and Contractors
   6. Review of proposed changes, Change Orders, and Payment Applications
   7. Implementation of quality control procedures
   8. Review of Schedule and revisions, if any.

1.4 SCHEDULE

A. A detailed construction schedule shall be issued by the Contractor, reviewed by the Architect, Owner, and thereafter shall be called the Schedule. This Schedule will become a part of the Contract Documents when reviewed and approved by the Owner and Architect. After the signing of the Contract, the Contractor, subcontractor, and/or material suppliers shall furnish sufficient labor forces, construction materials and equipment, and shall work such hours, including night shifts and overtime operations, at no additional expense to the Owner, as may be necessary to ensure the prosecution of the work in accordance with the Schedule.

B. Schedule shall be as indicated in Specification Section 01 01 00, and as approved by the Architect and the Owner.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 31 19

SECTION 01 33 00
SUBMITTALS

PART 1 GENERAL

1.1 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall submit shop drawings, product information, and samples to the Architect at the earliest practical time, and in the order of priority in which materials are required at the project site to maintain schedule. Contractor shall submit required information with such promptness so as to cause no delay in the work, or in that of any subcontractor.

B. Failure to submit shop drawings, product information, and samples in ample time to allow for proper review, approval, return, and distribution will not justify delays or extension of time for fabrication, deliveries, and installation of the work.

C. The Contractor shall thoroughly and accurately prepare and/or review shop drawings, product information, and samples for completeness and compliance with the Contract Documents, before submitting them to the Architect.

D. Each Sub-contractor shall submit their shop drawings, product information, and samples to the Contractor. Information shall be thoroughly checked and approved by the Contractor, for completeness and compliance with the Contract Documents, before submission to the Architect.
   1. Contractor shall affix his mark or stamp of approval to indicate that he has satisfied the review requirements.
   2. Deviation from requirements of the Contract Documents shall be clearly identified in the submittal.

1.2 CONTRACTOR'S SUBMISSION REQUIREMENTS

A. Time for Architect's review:
   1. The Contractor shall submit shop drawings, product information, and samples to the Architect in ample time to allow 10 working days for the Architect's review.

B. Transmittal Letter:
   1. The Contractor shall accompany all submittals with a transmittal letter containing the following information:
      a. Date.
      b. Project Name and Project Number.
      c. Contractor's Name and Address.
      d. Project Manual section and submittal number.
      e. The quantity of each type of information submitted.
      f. Description of information submitted.
      g. Notification of any deviations from the Contract Documents.
      h. Notification of any other pertinent information such as questions, clarifications, etc.

C. Quantity Requirements:
   1. Shop drawings: Submit in digital .pdf format.
   2. Product information: Submit in digital .pdf format. Poor quality or unclear scans of documents will be rejected.
   3. Samples: Submit three (3) samples or three (3) sets of samples.

D. Shop Drawings:
   1. Shop drawings shall bear the following identification and information:
      a. Date (use same date on each sheet in set).
      b. Project Name and Project Number.
      c. Name of Contractor, Sub-contractor, and/or supplier.
      d. Project Manual section and submittal number.
      e. Number sheets in a set consecutively and retain same numbering system throughout all revisions.
      f. Revision dates.
      g. Shop drawings shall in be submitted in digital .pdf format on sheet sizes as follows:
         1) Minimum size: 8-½" x 11".
         2) Preferred size: 11" x 17", or 24" x 36"
      h. Leave adequate clear space on each drawing for Architect's stamp.
      i. Reference to Specifications and/or Drawings, if applicable and practical.
      j. Reference to applicable standards, such as ASTM or Federal Specification numbers.
      k. Show complete and thorough identification, layout, details, and all pertinent information in order to fully describe and illustrate the work.
      l. Field measurements shall be made, as required, and noted on the shop drawings as such.
      m. Details and/or other information to show the relationship of materials to adjoining and/or adjacent materials and structures.
      n. Show or note any qualifications, departure, or deviation from the requirements of the Contract Documents.
      o. Show additional information as may be required by the Drawings and Specifications.
      p. Contractor's approval stamp.

E. Product Information:
   1. Product information shall bear the following identification:
      a. Date of submittal.
      b. Project Name and Project Number.
      c. Name of Contractor, Sub-contractor, and/or supplier/manufacturer.
      d. Project Manual section and submittal number.
      e. Contractor's approval stamp.
   2. Product Information shall include the following: Manufacturer's/Supplier's standard drawings, catalog cuts, data sheets, performance charts, schedules, brochures, diagrams, illustrations, and other standard descriptive data.
      a. Modify drawings to delete information which is not applicable.
      b. Supplement standard information to provide additional information applicable.
      c. Clearly mark to identify pertinent materials, products or models applicable.
      d. Show performance characteristics and capacities.
      e. Show dimensions and clearances required.
      f. Show wiring diagrams and controls.
   3. Refer to specification Section 018113 Sustainable Project Requirements for additional Product Information, Product data, or LEED Submittal requirements that shall be submitted. The Sustainable product information may be submitted with other product data, or as a separate submittal.

1.3 RESUBMISSION REQUIREMENTS

A. Shop Drawings: Revise original drawings as required and resubmit as specified for initial submission. Clearly indicate on revised drawings any changes which have been made, other than those requested by the Architect.

B. Product Information and Samples: Submit revised or new product information and/or new samples as required.

1.4 ARCHITECT'S RESPONSIBILITIES

A. The Architect shall review shop drawings, product information, and samples, in a timely manner, for conformance with the design concept of the project, as outlined in the General Conditions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 33 00

SUBSTITUTION REQUEST

(During the Bidding/Negotiating Stage)

Project: _____ Substitution Request Number: _____

_____ From: _____

To: _____ Date: _____

_____ A/E Project Number: _____

Re: _____ Contract For: _____

Specification Title: _____ Description: _____

Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No.: _____

Attached data includes product description, specifications, drawings, photographs, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation.

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

_____

Telephone: _____

A/E's REVIEW AND ACTION

☐ Substitution approved - Make submittals in accordance with Specification Section 01 25 00 Substitution Procedures.
☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01 25 00 Substitution Procedures.
☐ Substitution rejected - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by: Date:

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

Form Version: January 2013
CSI Form 1.5C

SECTION 01 35 00
OPERATING AND MAINTENANCE MANUAL

PART 1 GENERAL

1.1 WORK DESCRIPTION

A. Furnish Operating and Maintenance Manual at Substantial Completion of Project for all supplies, manufacturers, and systems installed.

B. Furnish As-Built drawings at Final Completion of Project.

1.2 SUBMITTALS

A. REQUIREMENTS:
1. Make all submittals to the Architect. Submit one (1) copy of Operating and Maintenance Manual for review. Submit three (3) copies after approval and one (1) copy in .pdf format.
2. The final submittal shall be made at Substantial Completion of the Project. A preliminary submittal shall be made when 90 percent of the work has been completed.
3. Each copy shall be bound in a vinyl hard back, three-ring loose leaf binder, with labels on the spine and on the front cover.
4. Prepare instructions and data by personnel experienced in maintenance and operation of described products.
5. Prepare full-size, clearly marked drawings that indicate as-constructed conditions of the Work.
6. All material within manual shall be new. Copies used in construction of the project are not acceptable.

PART 2 PRODUCTS

2.1 MANUALS

A. BINDER:
1. Binders shall be "hard back" vinyl, three ring, and loose-leaf type of one solid color. All binders shall be the same color. Binder spine and front shall display labels containing the name of the Project, name of the Owner, and the name of the Contractor.
2. Provide tabbed flyleaf for each separate product and system, with typed description of product and major component parts of equipment.
3. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

B. CONTENTS:
1. Table of Contents: Provide title of project; names, addresses, and telephone for each Product or System: List names, addresses and telephone numbers of Architect and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.
2. For each Product or System: List names, addresses and telephone numbers of manufacturers and suppliers, including local source of supplies and replacement parts.
3. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

4. Drawings: Product data to illustrate relations of component parts of equipment and systems. (Do not use Project Record Documents as maintenance drawings.)
5. Type Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
6. Warranties and Bonds: Bind in copy of each.
7. Equipment, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. (Provide information for re-ordering custom manufactured products.)
8. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
9. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
10. Maintenance Requirements: Include routine procedures and guide for repair, and reassemble instructions; and alignment, adjusting, and checking instructions.
11. Include manufacturer's printed operation and maintenance instructions with a copy of the approved shop drawings with all data concerning all changes made during construction.
12. Additional Requirements: As specified in individual product specification sections.

C. INSTRUCTION OF OWNER PERSONNEL:
1. Upon substantial completion, instruct Owner's designated personnel in operation, adjustment, and maintenance of products and systems, at agreed upon times. Use the Operating and Maintenance Manuals for training on use of equipment.
2. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detain to explain all aspects of operation and maintenance.
3. Prepare and insert additional data in Operation and Maintenance Manual as needed for such data which becomes apparent during instruction.

END OF SECTION 01 35 00

SECTION 01 40 00
QUALITY CONTROL SERVICE

PART 1 GENERAL

1.1 SUMARY

A. This Section specifies administrative and procedural requirements for quality control services.

B. Quality control services include inspections and tests and related actions including reports, performed by independent agencies, governing authorities, and the Contractor. They do not include Contract enforcement activities performed by the Architect.

C. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve the Contractor of responsibility for compliance with Contract Document requirements.

D. Requirements of this Section relate to customized fabrication and installation procedures, not production of standard products.
   1. Specific quality control requirements for individual construction activities are specified in the Sections that specify those activities. Those requirements, including inspections and tests, cover production of standard products as well as customized fabrication and installation procedures.
   2. Inspections, test and related actions specified are not intended to limit the Contractor's quality control procedures that facilitate compliance with Contract Document requirements.
   3. Requirements for the Contractor to provide quality control services required by the Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.2 RESPONSIBILITIES

A. Owner Responsibilities:
   1. The Owner will provide inspections, tests and similar quality control services specified to be performed by independent agencies and not by the Contractor, except where they are specifically indicated as the Contractor's responsibility or are provided by another identification entity. Costs for these services will be paid by the Owner and are not to be included in the Contract Sum.
      a. Owner Testing Service will provide:
         1) Compression tests of concrete.
         2) Structural steel test and inspection of welds and bolting.
         3) Soils at the bottom of footing excavations, if any.
         4) All required field density tests.
         5) Field tests of masonry mortar bond with face brick or stone.
         6) Inspection of reinforcing steel which is in place
         7) All special tests and inspections required under the Indiana Building Code.
         8) Topsoil testing.
         9) Indoor air testing/sampling.
   2. Retesting: The Contractor is responsible for retesting where results of required inspections, tests, or similar services prove unsatisfactory and do not indicate compliance with Contract Document requirements, regardless of whether the original test was the Contractor's responsibility. Cost of retesting construction revised or replaced by the

Contractor is the Contractor's responsibility, where required tests were performed on original construction.

3. Associated Services: The Contractor shall cooperate with agencies performing required inspections, tests and similar services and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required included but are not limited to:
   a. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests.
   b. Taking adequate quantities of representative samples of materials that require testing or assisting the agency in taking samples.
   c. Providing facilities for storage and curing of test samples, and delivery of samples to testing laboratories.
   d. Providing the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.
   e. Security and protection of samples and test equipment at the Project site.

B. Coordination: The Contractor and each agency engaged to perform inspections, tests and similar services shall coordinate the sequence of activities to accommodate required services with a minimum of delay. In addition to the Contractor and each agency shall coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests. The Contractor is responsible for scheduling times for inspections, tests, taking samples and similar activities.

1.3 SUBMITTALS

A. The independent testing agency shall submit a certified written report of each inspection, test or similar service, to the Architect with a copy to the Contractor, unless the Contractor is responsible for the service. If the Contractor is responsible for the service, submit a certified written report of each inspection, test, or similar service through the Contractor to the Architect.
   1. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
   2. Report Data: Written reports of each inspection, test or similar service shall include, but not be limited to:
      a. Date of issue.
      b. Project title and number.
      c. Name, address and telephone number of testing agency.
      d. Dates and locations of samples and tests or inspections.
      e. Names of individuals making the inspection or test.
      f. Designation of the Work and test method.
      g. Identification of product and Specification Section.
      h. Complete inspection or test data.
      i. Test results and an interpretation of test results.
      j. Ambient conditions at the time of sample-taking and testing.
      k. Comments of professional opinion as to whether inspected or tested Work complies with Contract Document requirements.
      l. Name and signature of laboratory inspector.
      m. Recommendations on retesting.

1.4 QUALITY ASSURANCE

A. Qualification for Service Agencies: Engage inspection and testing service agencies, including independent testing laboratories, which are prequalified as complying with "Recommended Requirements for Independent Laboratory Qualification" by the American Council of Independent Laboratories, and which specialize in the types of inspections and tests to be performed.

B. Each independent inspection and testing agency engaged on the Project shall be authorized having jurisdiction to operate in the State in which the Project is located.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 REPAIR AND PROTECTION

A. General: Upon completion of inspection, testing, sample-taking, and similar services, repair damaged construction and restore substrates and finishes to eliminate deficiencies, including deficiencies in visual qualities of exposed finishes. Comply with Contract Document requirements for "Cutting and Patching."

B. Protect construction exposed by or for quality control service activities, and protect repaired construction.

C. Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing or similar services.

END OF SECTION 01 40 00

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Provide temporary services and facilities, including utilities, construction and support facilities, security and protection, and other miscellaneous services, as required for the work.

B. The Owner will assist in coordinating the location of Project staging areas and Contractor employee parking. The Contractor must contain construction activities within the areas indicated by the Owner and on the Contract Documents.

C. Temporary construction and support facilities: Include temporary heat/cooling, field offices and storage sheds, temporary roads and paving, sanitary facilities including drinking water, de-watering facilities and drains, temporary enclosures, temporary Project identification signs and bulletin boards, waste disposal services, rodent and pest control, construction aids and miscellaneous services and facilities as required for the work.

D. Security and protection facilities: Include temporary fire protection, barricades, warning signs, lights, environmental protection, shoring and bracing.

1.2 QUALITY ASSURANCE

A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to: Building Code requirements, health and safety regulations, utility company regulations; Police, Fire Department and Rescue Squad; and environmental protection regulations.

B. Standards: comply with NFPA Code 241, "Building Construction and Demolition Operations", ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition", and NECA Electrical Design Library "Temporary Electrical Facilities".

C. Refer to "Guidelines for Bid Conditions for Temporary Job Utilities and Services", prepared jointly by AGC and ASC, for Industry recommendations.

D. Electrical Service: Comply with NEMA, NECA and UL standards and regulations for temporary electric service. Install service in compliance with National Electric Code (NFPA 70).

E. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certification and permits.

F. Indoor Air Quality (IAQ) Plan: Interior activities of the Moisture-Protection Plan, Dust-And HVAC-Control Plan, and other environmental plans shall be compiled into the Environmental Protection Plan: After the contract is awarded and prior to the commencement of the work, the Contractor shall meet with the Owner and LEED Consultant to discuss the proposed Environmental Protection Plan and to develop mutual understanding relative to details of environmental protection. This required meeting may occur in the course of other design or construction coordination meetings. Not more than 20 days after the meeting, the Contractor shall prepare and submit the plan for approval, a written and/or graphic Indoor Environmental Protection Plan including, but not limited to, the following:

1. Name(s) of person(s) within the Contractor's organization who is (are) responsible for ensuring adherence to the Environmental Protection Plan, and Certifications by OSHA, ASHRAE, the USGBC, or other related health and safety organizations.
2. Name(s) and qualifications of person(s) responsible for training the subcontractors and other persons on site on details and execution of Contractor's environmental protection personnel.
3. Description of the Contractor's environmental protection personnel training program, including but not limited to foremen, superintendents, project managers and workers with the Contractor's organization, for subcontractors and other persons.
4. Items listed elsewhere in the specification to protect the interior environment and cleanliness of the project.

1.3 GENERAL

A. Maintain Traffic: Do not close or obstruct streets, sidewalks, alleys, and passageways without permit. Do not place or store material in streets, alleys, or passageways.
   1. Conduct operations with minimum interference with roads, streets, alleys, sidewalks and existing structures.
   2. Provide, erect and maintain lights, barriers, and the like required by local authorities.

B. Utilities: Coordinate with local utility and Owner to install temporary service. Where utility provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with utility's recommendations.
   1. Prior to temporary utility availability, provide trucked-in service.
   2. Obtain easements to bring temporary utilities to the site where the Owner's easements cannot be used for that purpose.
   3. Use Charges: Contractor shall pay for cost or use charges for temporary facilities and utility taps Exce

C. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access and in Owner designated areas.

D. Maintain temporary construction and support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under condition acceptable to the Owner.

E. Security and Protection Facilities: Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer as requested by Architect.

1.4 CONSTRUCTION FENCE

A. Open-mesh fencing at 11 gage, galvanized 2" chain link fabric fencing, 6 feet high, galvanized steel pipe, 1 1/2 inch I.D. for line posts and 2 1/2 inch I.D. for corner and gate posts.

1.5 WATER SERVICE

A. Provide water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.
   1. Arrange and pay for the installation of temporary water service except as allowed in Paragraph 1.1 C. above.

B. Install branch piping with taps located so that water is available throughout the construction site by the use of hoses. Protection piping and fittings against freezing.

1.6 TEMPORARY DRINKING WATER

A. Provide adequate supply or chilled potable water. The Contractor is responsible for supplying water for his workmen.

1.7 TEMPORARY ELECTRICITY AND POWER

A. Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload protected disconnects, automatic ground-fault interrupters and main distribution switch gear.
   1. Provide temporary connections for fan motors, pumps, burners, boilers, etc., when heat or ventilation is required during course of construction.
   2. Contractors shall provide their own branch circuit ground fault protection as required by NEC and OSHA.
   3. Contractors or sub-contractor shall provide the necessary extension cords required.

2.2 TEMPORARY LIGHTING

A. Whenever required, provide temporary lighting with local switching.

B. Provide lighting that will fulfill security and protection requirements, without operation of entire system; and will provide adequate illumination for construction operations and traffic conditions.

2.3 TEMPORARY HEAT, COOLING AND VENTILATION

A. Provide temporary heat, cooling and ventilation as required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures, dust, dirt or high humidity, including humidity that regularly occurs by weather on site. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.

B. Before enclosure: Provide and maintain the necessary portable heating equipment, including fuel and temporary electrical connections, to provide temporary heat wherever and whenever heat is needed until the building is enclosed and the permanent heating system is available for temporary use.
   1. Provide vented self-contained LP gas or fuel oil heaters with individual space thermostatic control. Use of gasoline-burning space heaters, open flame, or salamander type heating units is prohibited.
   2. The Contractor shall pay for fuel and power used.

C. After enclosure (or "in the dry") of building, a working temperature of not less than 50°F shall be maintained in all parts of the building during working hours, with a minimum of 35°F outside of work hours unless otherwise required by individual Sections. This includes all areas where work has been installed which might be subject to damage by freezing.
   1. Moisture Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.
      a. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
      b. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.

c. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and concrete cutting, and describe plans for dealing with water from these operations.
d. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

2. Dust and HVAC Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include Dust-HVAC Control Plan in IAQ Plan for compliance with LEED v4 BD+C Credit Construction Indoor Air Quality Management Plan (IAQMP).
3. Provide Dust and HVAC control plan with options and measures to prevent operating permanent Air Handling Units and other equipment, and options which permit operating permanent Air Handling Units and other equipment.
4. Identify further options if proposed measures are later determined to be inadequate. Include the following:
   a. Locations of dust-control partitions at each phase of work.
   b. HVAC system isolation schematic drawing.
   c. Waste handling procedures.
   d. Other dust-control measures.
   e. HVAC Protection.
   f. Source Control.
   g. Pathway Interruption.
   h. Housekeeping.
   i. Scheduling.
   j. Product data for temporary filtration media.
   k. Product data for filtration media used during occupancy.
5. If Owner authorizes in writing the use of permanent heating, cooling, and ventilating systems during construction period, contractor shall install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
   a. Provide Product and Manufactures Data for MERV 8 temporary Filters.
   b. Provide a plan, schedule and records of replacing filters as necessary.
   c. Replace all air filters immediately prior to occupancy.
   d. Premature removal or failure of filters will require the cleaning of all ducts and air handling equipment

D. For a period of 7 days prior to interior finishing (painting or coatings, etc.) and until final acceptance for occupancy by Owner, maintain temperatures of 68ºF during working hours and 60ºF at all other times. Provide mitigation for humidity over 90%.

E. Just prior to Substantial Completion provide maintenance and/or repairs required to place all systems in "like new" condition, including but not limited to the following:

F. Oiling and greasing of equipment or parts that would normally require same in a periodic maintenance program.
   1. Replacement of significantly worn parts and parts that have been subject to unusual operating conditions.
   2. The provisions of this paragraph shall not in any way change or modify the requirements of the General Conditions, Article 12, concerning the warranty-guarantee period which follows Substantial Completion.
   3. Contractor shall pay all costs, if any to extend manufacturer's warranty on all items of equipment used for temporary facilities.

2.4 SANITARY FACILITIES

A. Provide facilities for use of all trades. Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs.
   1. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy.
   2. Owner's fcilities will not be allowed for use.

2.5 TEMPORARY ENCLOSURES

A. Provide temporary enclosure for protection of construction in progress and completed, from exposure, foul weather, other construction operations and similar activities.

B. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.

C. Install tarpaulins securely, with incombustible wood framing and other materials. Close openings of 25 square feet or less with plywood or similar materials.

D. Close openings through floor or roof decks and horizontal surfaces with load-bearing wood-framed construction.

2.6 TEMPORARY LIFTS AND HOISTS

A. Provide facilities for hoisting materials and employees.

2.7 PROJECT IDENTIFICATION SIGNS

A. The Owner may provide and install a project identification sign. Location will be coordinated with Contractor.

B. Temporary Signs: Prepare signs to provide directional information to construction personnel and visitors. Do not permit installation of unauthorized signs.

2.8 COLLECTION AND DISPOSAL OF WASTE

A. Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80°F (27°C).

B. Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material in a lawful manner.

2.9 FIRE PROTECTION

A. Until fire protection needs are supplied by permanent facilities, install and maintain temporary fire protection facilities of the types needed to protect against reasonable predictable and controllable fire losses. Comply with NFPA 10 "Standard" for Portable Fire Extinguishers", and NFPA 241 "Standard for Safeguarding Construction, Alterations and Demolition Operations".
   1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near stairwell.
   2. Store combustible materials in containers in fire-safe locations.

3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways and other access route for fighting fires. Prohibit smoking in hazardous fire exposure areas.
4. Provide supervision of welding operations, combustion type temporary heating units, and similar sources of fire ignition.

2.10 BARRICADES, WARNING SIGNS AND LIGHTS

A. Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.

2.11 SECURITY ENCLOSURE AND LOCKUP

A. Provide substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to resist unauthorized entrance, vandalism, theft, and similar violations of security.

B. Where materials and equipment must be stored, and are of value of attractive of theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.

2.12 ENVIRONMENTAL PROTECTION

A. Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations, Storm Water Pollution Prevention (SWPP or erosion and sedimentation control plan, 'ESCP'), sustainable construction goals, and minimize the possibility that air, waterways, and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment that produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

B. Temporary Protection of Disturbed Areas: Construct diversion ditches, benches, and berms to retard and divert runoff from the construction site to protected drainage areas as indicated in the Contract Documents. Protect adjacent areas from despoilment by temporary excavations and embankments.

C. Institute effluent quality monitoring programs as required by Federal, State, and local environmental agencies.

D. Erosion and Sedimentation Control Devices: The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of the Contractor's activities. Construct or install all temporary and permanent erosion and sedimentation control features on the Erosion Control Plan and specifications. Maintain temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing, and mulching, until permanent drainage and erosion control facilities are completed and operative.

2.13 FIELD ENGINEERING

A. The Contractor shall provide appropriate base lines and benchmarks at each level of the building.

B. The Contractor and Subcontractors shall be responsible for the layout of his work and the coordination of his work with other trades.

C. The Contractor and Subcontractors shall field verify all dimensions relating to his work as shown on the drawings, and report any errors to the Architect before commencing work.

2.14 TEMPORARY OFFICE

A. Provide an on site temporary office for the duration of the Project.

B. Office shall be adequate for storage of Drawings, shop drawings, samples and Construction Documents.

C. Temporary Controls: Barriers, enclosures, and fencing.

D. Waste removal facilities and services.

E. Project identification sign.

2.15 RELATED REQUIREMENTS

A. Section 01 51 00 - Temporary Utilities.

2.16 TEMPORARY UTILITIES

A. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.

B. New permanent facilities may be used.

2.17 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.

2.18 FENCING

A. Provide 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks.

2.19 WASTE REMOVAL

A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.

B. Provide containers with lids. Remove trash from site regularly.

C. 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.

D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

2.20 PROJECT IDENTIFICATION

A. Provide project identification sign of design, construction, and location approved by Owner.

B. No other signs are allowed without Owner permission except those required by law.

PART 2 PRODUCTS

3.1 MATERIALS

A. Polyethylene sheet: reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 test method 2.

B. Dust-control adhesive-surface “walk-off mats" paragraph below for dust control at entries to dust-controlled work areas.

C. Insulation: unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

D. Filter cloth: MERV 8 according to ASHRAE 52.2.

3.2 EQUIPMENT

A. Fire extinguishers: portable, ul rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 50 00

SECTION 01 71 00
PROJECT CLOSEOUT

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Definitions: Closeout is defined to include general requirements near end of Contract Time, in preparation for final acceptance, final payment, normal termination of contract, occupancy by Owner and similar actions evidencing completion of the work. Specific requirements for individual units of work are specified in various Sections. Time of Closeout is directly related to "Substantial Completion", and therefore may be either a single time period for entire work or a series of time periods for individual parts of the work which have been certified as substantially complete at different dates. That time variation (if any) shall be applicable to other provisions of this section.

B. Maintain at the site one record copy of:
   1. Contract Documents.
   2. Approved shop drawings, product data and samples.
   3. Record Documents.
   4. Schedule, submittal schedule, record of progress payments, and insurance documents.

1.2 PREREQUISITES TO SUBSTANTIAL COMPLETION

A. General: Prior to requesting Architect's inspection for certification of substantial completion (for either entire work or portions thereof) complete the following and list known exceptions in request:
   1. In progress payment request, coincident with or first following date claimed, show either 100% completion for portion of work claimed as "substantially complete", or list incomplete items, value of incompletion, and reasons for being incomplete.
   2. Include supporting documentation for completion.
   3. Submit statement showing accounting of changes to Contract Sum.
   4. Advise Owner of pending insurance changeover requirements.
   5. Submit specific warranties, workmanship/maintenance bond, maintenance agreements, final certifications, and similar documents.
   6. Submit Record Drawings, and Operation and Maintenance Manuals.
   7. Deliver spare parts, extra stocks of materials, and similar physical items to Owner.
   8. Complete final cleaning requirements.
   9. Repair and restore marred exposed finishes.

B. Inspection Procedures: Upon receipt of Contractor's request, Architect will either proceed with inspection or advise Contractor of prerequisites not fulfilled. Following initial inspection, Architect will either prepare certificate of substantial completion, or advise the Contractor of work which must be performed prior to issuance of certificate; and repeat inspection when requested and assured that work has been substantially completed. Results of completed inspection will form initial "punch-list" for final acceptance.

1.3 PREREQUISITES TO FINAL ACCEPTANCE

A. General: Prior to requesting Architect's final inspection for certification of final acceptance and final payment, as required by The General Conditions (Section 00 07 00), complete the following and list known exceptions (if any) in request:

1. Submit final payment request with final releases, and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
2. Submit updated final statement, accounting for changes to Contract Sum.
3. Submit Escrow Payment.
4. Submit certified copy of Architect's final punch-list of itemized work to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, endorsed and dated by Architect.
5. Submit consent of surety to Final Payment.
6. Revise and submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Re-inspection Procedure: Upon receipt of Contractor's notice that the work has been completed, including punch-list items resulting from earlier inspections, and excepting incomplete items delayed because of acceptable circumstances, Architect will re-inspect the work. Upon completion of re-inspection, Architect will either prepare certificate of final acceptance or advise Contractor of work not completed or obligations not fulfilled as required for final acceptance. If necessary, the procedure will be repeated until the work is accepted.

1.4 RECORD DOCUMENT SUBMITTALS

A. Project Record Documents: See Section 01 72 00.

B. Operating and Maintenance Manuals: See Section 01 35 00.

1.5 FINAL CLEANING

A. General: Special cleaning for specific units of work. Provide final cleaning of the work, at time indicated, consisting of cleaning each surface or unit of work to normal "clean" condition expected for a first-class building cleaning and maintenance program. Comply with manufacturer's instructions for cleaning operations. The following are examples of cleaning levels required:
   1. Remove labels, which are not required as permanent labels.
   2. Remove debris and surface dust from interior.
   3. Vacuum clean carpeted surfaces and similar soft surfaces.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 71 00

SECTION 01 72 00
PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.1 SECTIONS INCLUDE

A. Project Record Documents.

1.2 RELATED SECTIONS

A. Section 01 71 00 - Project Closeout.

1.3 PROJECT RECORD DOCUMENTS

A. The Contractor shall maintain, on a frequent and regular basis, at the project site, for periodic inspection by the Owner and Architect, one complete set of Project Record Documents, as follows, for the sole purpose of recording all changes, errors, omissions, corrections, and discrepancies occurring during the course of the Work.
   1. Contract Documents (including the Drawings and Specifications).
   2. Addenda.
   3. Construction Change Directives.
   4. Change Orders and other modifications to the contract.
   5. Reviewed shop drawings, product information and samples.

B. Project Record Documents shall be accessible to all Project personnel to make immediate notes or revisions.
   1. Maintain daily and keep current with all changes.
   2. Maintain a register of the changes and the reporting individual.

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

D. Store Project Record Documents separate from other documents used for construction.

E. Record information concurrent with construction progress.

F. Drawings: Legibly mark each item to record all revisions and actual construction including:
   1. Show location of interior mechanical and electrical services, utilities, and appurtenances concealed in the facility, referenced to visible and accessible features of the facility.
   2. Structural and architectural dimensional changes to the Drawings.
   3. Revisions, no matter how minor, to any detail shown on the Drawings.
   4. Details not included on the Drawings.

G. Specifications: Legibly mark and record, within each applicable 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.

H. The maintenance of this information will be a condition for acceptance of monthly applications for payment.

1. Failure to maintain Project Record Documents, as outlined, will be cause for rejection of Contractor's pay request.

1.4 SUBMITTALS

A. At completion of the project, the Project Record Documents shall be reviewed as to accuracy and completeness by the Contractor, prior to submission to the Owner.

B. Project Record Documents shall be submitted to the Architect within thirty (30) days of the date of substantial completion. Acceptability of Project Record Documents shall be a condition for final payment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 72 00

SECTION 01 73 29
CUTTING AND PATCHING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for cutting and patching.
   1. Unless specifically noted or detailed otherwise, cutting and patching shall be the responsibility of that Contractor or Subcontractor directly related to the Work requiring the cut or patch.
   2. Execute cutting (including excavating), fitting or patching of Work, required to:
      a. Make several parts fit properly.
      b. Uncover Work to provide for installation of ill-timed Work.
      c. Remove and replace defective Work.
      d. Remove and replace Work not conforming to requirements of Contract Documents.
      e. Remove samples of installed Work as specified for testing.

B. Requirements of this Section apply to mechanical and electrical installations. Refer to appropriate Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

1.2 SUBMITTALS

A. Cutting and Patching Proposal: Submit a written proposal to the Architect describing procedures well in advance of the time cutting and patching will be performed before proceeding with cutting and patching. Include the following information, as applicable, in the proposal:
   1. Describe the extent of cutting and patching required. Show how it will be performed and indicate why it cannot be avoided. Describe alternatives to cutting and patching.
   2. Describe anticipated results in terms of changes to existing construction. Include changes to structural elements and operating components as well as changes in the building's appearance and other significant visual elements.
   3. List products to be used and firms or entities that will perform Work.
   4. Indicate dates when cutting and patching will be performed. Include written notice to the Architect designating time Work will be uncovered to provide for observation.
   5. Should conditions of Work or schedule indicate change or materials or methods than those specified in Contract Documents, submit written recommendations to Architect including:
      a. Conditions indicating change.
      b. Recommendations for alternative materials or methods.
      c. Submittals as required for substitutions.
   6. Cost estimate for cutting and patching. Include designation of party responsible for costs of cutting and patching.
   7. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out-of-service. Indicate how long service will be disrupted.
   8. Where cutting and patching involves adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with the original structure.

1.3 QUALITY ASSURANCE

A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would change their load-carrying capacity or load-deflection ratio.
   1. Obtain approval of the cutting and patching proposal before cutting and patching the following structural elements:
   2. Foundation construction.
      a. Bearing and retaining walls.
      b. Structural concrete.
      c. Structural steel.
      d. Lintels.
      e. Structural decking.
      f. Miscellaneous structural metals.
      g. Exterior curtain-wall construction.
      h. Equipment supports.
      i. Piping, ductwork, vessels, and equipment.

B. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in the Architect's opinion, reduce the building's aesthetic qualities. Do not cut and patch construction in a manner that would result in visual evidence of cutting and patching. Remove and replace construction cut and patched in a visually unsatisfactory manner.

C. Approval by the Architect to proceed with cutting and patching does not waive the Architect's right to later require complete removal and replacement of unsatisfactory Work.

1.4 WARRANTY

A. Existing Warranties: Replace, patch, and repair material and surfaces cut or damaged by methods and with materials in such a manner as not to void any warranties required or existing.
   1. Confirm with warranty provider if a certified Contractor is required to perform cutting, patch and repair Work prior to commencement of any Work.

1.5 COSTS

A. Costs caused by ill-timed or defective Work, or Work not conforming to Contract Documents, including costs for additional services of the Architect: Party responsible for ill-timed, rejected or nonconforming Work.

B. Work done on instructions of Architect other than defective or nonconforming Work: Owner.

PART 2 PRODUCTS

2.1 MATERIALS, GENERAL

A. Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible if identical materials are unavailable or cannot be used. Use materials whose installed performance will equal or surpass that of existing materials.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed before cutting. If unsafe or unsatisfactory conditions are encountered, take corrective action before proceeding.
   1. Inspect elements that might be subject to movement or damage during excavating and/or backfilling.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect new and existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.

C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Avoid cutting existing pipe, conduit, or ductwork serving the building, but scheduled to be removed or relocated until provisions have been made to bypass them.

3.3 PERFORMANCE

A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.
   1. In addition to Contract requirements, upon written instruction of Architect:
      a. Uncover and restore Work to provide for Architect's observation of covered Work.
      b. Remove samples of installed materials for testing.
      c. Remove Work to provide for alteration of existing Work.
   2. Do not endanger any Work by cutting or altering Work or any part of the Work.
   3. Do not cut or alter Work to provide for alteration of existing Work.

B. Cutting: Cut existing construction using methods least likely to damage elements retained or adjoining construction. Where possible, review proposed procedures with the original Installer; comply with the original Installer's recommendations.
   1. In general, where cutting, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   2. To avoid marring existing finish surfaces, cut or drill from the exposed or finished side into concealed surfaces.
   3. Cut through concrete and masonry using a cutting machine, such as a carborundum saw or a diamond-core drill.
   4. Comply with requirements of applicable Division 2 Sections where cutting and patching requires excavating and backfilling.
   5. Where services are required to be removed, relocated, or abandoned, by-pass utility services, such as pipe or conduit, before cutting. Cut-off pipe or conduit in walls or partitions to be removed. Caps, valve, or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after bypassing and cutting.
   6. Comply with prohibitions in Division 5 regarding flame cutting of steel.

C. Patching: Patch with durable seams that are invisible as possible. Comply with specified tolerances.
   1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
   2. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
   3. Where removing walls or partition extends one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform color and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
      a. Where patching occurs in a smooth painted surface, extend final paint coat over entire unbroken surface containing the patch after the area has received primer and a second coat.
   4. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.4 CLEANING

A. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar items. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

END OF SECTION 01 73 29

SECTION 01 74 00
PROJECT CLEANING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Progress cleaning.

B. Final cleaning.

1.2 GENERAL

A. In general, each Sub-contractor shall be responsible for all clean-up and cleaning of their Work. The Contractor is responsible to maintain a clean and efficient Project Site and Work area.

B. Cleaning of certain specific products is specified in their respective Sections of the Project Manual.

C. Conduct all clean-up operations to comply with local ordinances and hazardous waste laws.
   1. Do not burn or bury rubbish and waste materials on Project site.
   2. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary sewers.
   3. Do not dispose of wastes into streams or waterways.

D. Conduct all clean-up operations to maintain safety and hazard control.
   1. Store volatile wastes in covered metal containers and remove from premises daily.
   2. Prevent accumulation of wastes which create hazardous conditions.
   3. Provide adequate ventilation during use of volatile or noxious substances.

1.3 PROGRESS CLEANING

A. As a result of, or during the performance of the Work, the Contractor shall perform clean-up on a continuing basis.

B. Perform clean-up to ensure that the building, Project site, and all adjacent properties are maintained free from accumulations of waste, debris, and rubbish.

C. At reasonable intervals or as conditions require, perform Project site clean-up of waste and surplus materials. Maintain and clean public and private streets, roadways, and sidewalks as required.

D. The Contractor shall provide, at a convenient location on the Project site, a trash container of appropriate size, and shall be responsible for periodic servicing of the trash container.

E. Each Sub-contractor shall be responsible to collect and deposit in the trash container all waste, debris, and rubbish caused by their operations, on a daily basis, except that each Sub-contractor shall collect and remove from the job site their own liquid waste and other waste requiring special handling for disposal.

F. Perform clean-up without causing damage to the work. Schedule clean-up so that dust or debris will not fall on wet, newly painted or coated surfaces.

G. Contractor shall maintain the Project site of high weeds.

H. If Contractor fails to keep project site clean, the Owner may have project cleaned and all costs incurred will be paid by the Contractor.

1.4 FINAL CLEANING

A. As a result of, and following the performance of the Work, the Contractor shall perform cleaning of their finished work, in the preparation for final project assessment.

B. Use professional cleaners for final cleaning.

C. Remove grease, dust, dirt, stains, labels, fingerprints, tape, protective coating, coverings, and other foreign materials from sight-exposed interior and exterior finished surfaces.

D. Repair, replace, patch, and touch-up marred surfaces to specified finish to match the finish of the product.

E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

F. Broom clean all exterior concrete surfaces.

G. Clean project site. Sweep paved areas, and rake clean landscaped surfaces.

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

I. Should the Architect determine that additional cleaning is required, following substantial completion and final cleaning of the work by the Contractor, the Contractor responsible for such additional cleaning shall bear the associated cost.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 74 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Slabs-on-grade.

B. Related Sections include the following:

1. Division 09 Sections relating to moisture requirements of floor finishes applied over concrete slabs.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

A. Product Data with Shop Drawings:

1. Product Data: For each type of product indicated.
2. Shop Drawings:

a. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates..

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.
4. Fiber reinforcement.
5. Floor and slab treatments.
6. Vapor barriers.

C. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.

D. Field quality-control test and inspection reports.

E. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

2.3 REINFORCEMENT ACCESSORIES

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

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I/II, gray. Supplement with the following:

a. Fly Ash: ASTM C 618, Class C or F.

B. Normal-Weight Aggregates: ASTM C 33, Class 3S 3M coarse aggregate or better, graded. Provide aggregates from a single source[with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials].

1. Maximum Coarse-Aggregate Size: SEE CONCRETE MIX SCHEDULE.
2. Fine Aggregate: SEE CONCRETE MIX SCHEDULE.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.6 FIBER REINFORCEMENT

A. Synthetic Fiber: fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.

2.7 VAPOR BARRIERS

A. Plastic Vapor Barrier: ASTM E 1745, Class A with a permeance of 0.01 as tested before and after mandatory conditioning (ASTM E 1745 Section 7.1 and subparagraph 7.1.1-7.1.5) less than 0.01 perms (grains/(ft2 hr in Hg)). Include manufacturer's recommended adhesive or pressure-sensitive tape.

B. Plastic Vapor Retarder: ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products:

a. Axim Concrete Technologies; Cimfilm.
b. Burke by Edoco; BurkeFilm.
c. ChemMasters; Spray-Film.
d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
e. Dayton Superior Corporation; Sure Film.
f. Euclid Chemical Company (The); Eucobar.
g. Kaufman Products, Inc.; Vapor Aid.
h. Lambert Corporation; Lambco Skin.
i. L&M Construction Chemicals, Inc.; E-Con.
j. MBT Protection and Repair, Div. of ChemRex; Confilm.
k. Meadows, W. R., Inc.; Sealtight Evapre.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
n. Sika Corporation, Inc.; SikaFilm.
o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
p. Unitex; Pro-Film.
q. US Mix Products Company; US Spec Monofilm ER.
r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

s.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

2.9 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.10 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete per CONCRETE MIX DESIGN.

2.11 FABRICATING REINFORCEMENT

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

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).

3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.2 VAPOR BARRIERS

A. Plastic Vapor Barriers: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor barrier. Repair damage and reseal vapor barrier before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.4 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

C. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

D. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.5 CONCRETE PLACEMENT

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

1. Verify that vapor barrier is in place and not damaged and that lapped seams are taped properly in compliance with manufacturer's instructions. Do not proceed with concrete placement until damaged vapor barrier has been patched, sealed, and repaired.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.

5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.6 FINISHING FLOORS AND SLABS

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

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in 1 direction.

1. Apply scratch finish to surfaces [indicated] [and] [to receive concrete floor toppings] [to receive mortar setting beds for bonded cementitious floor finishes] <Insert locations>.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

3.7 MISCELLANEOUS CONCRETE ITEMS

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

B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.8 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project..

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.10 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

C. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

D. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

E. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel reinforcement placement.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; [ASTM C 173/C 173M, volumetric method, for structural lightweight concrete;]one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.
8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
11. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.

E. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 48hours of finishing.

END OF SECTION

SECTION 03 35 11
CONCRETE FLOOR FINISHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface treatments for new and existing concrete floors and slabs.

B. Liquid densifiers and hardeners.

C. Clear coatings.

1.2 RELATED REQUIREMENTS

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

B. Section 03 30 00 - Cast-in-Place Concrete: Curing compounds that also function as sealers.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with concrete floor placement and concrete floor curing.

1.4 SUBMITTALS

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

B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.

C. Product Data: Manufacturer's published data and installation instructions for concrete polishing system and finishing products, including manufacturer's installation instructions, information on compatibility of different products, and limitations.

D. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

E. Specimen Warranty: Manufacturer warranty.

1.5 QUALITY ASSURANCE

A. For slabs indicated to receive concrete polishing system, do not proceed with concrete polishing unless manufacturer's representative and specialized equipment is present for every day of placement.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

A. Maintain light level equivalent to a minimum 200 W light source at 8 feet above the floor surface over each 20 foot square area of floor being finished.

B. Do not finish floors until interior heating system is operational.

C. Maintain ambient temperature of 50 degrees F minimum.

1.8 WARRANTY

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

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

C. Finish Warranty: Provide five-year manufacturer warranty against excessive degradation of finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.1 CONCRETE FLOOR FINISH APPLICATIONS

A. Liquid Densifier and Hardener:

B. Clear Coating:

2.2 DENSIFIERS AND HARDENERS

A. Liquid Densifier and Hardener: Penetrating chemical compound that reacts with concrete, filling the pores, hardening, and dustproofing.
   1. Composition: Lithium silicate.
   2. Products:
      a. Euclid Chemical Company; ULTRASIL LI+: www.euclidchemical.com/#sle.
      b. PROSOCO, Inc; Consolideck LS: www.prosoco.com/consolideck/#sle.
      c. SpecChem, LLC; LithSeal SC: www.specchemllc.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 COATINGS

A. Low Gloss Clear Coating: Transparent, nonyellowing, acrylic polymer-based coating.
   1. Composition: Water-based.
      a. Nonvolatile Content: 20 percent, minimum, when measured by volume.
      b. Products:
         1) Concrete Sealers USA; TS202: www.concretesealersusa.com/#sle.
         2) Euclid Chemical Company; www.euclidchemical.com.
         3) PROSOCO, Inc; www.prosoco.com/consolideck.
         4) Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that floor surfaces are acceptable to receive the work of this section.

B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.

3.2 GENERAL

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

3.3 COATING APPLICATION

A. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.

B. Verify that water vapor emission from concrete and relative humidity in concrete are within limits established by coating manufacturer.

C. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.

D. Apply coatings in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

END OF SECTION 03 35 11

SECTION 04 20 00
UNIT MASONRY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Concrete block foundations.

B. Mortar and grout.

C. Reinforcement and anchorage.

D. Flashings.

E. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 05 50 00 - Metal Fabrications: Loose steel lintels.

B. Section 06 10 00 - Rough Carpentry: Nailing strips built into masonry.

C. Section 07 21 00 - Thermal Insulation: Insulation for cavity spaces.

D. Section 07 25 00 - Weather Barriers: Water-resistive barriers applied to exterior face of backing sheathing or unit masonry substrate.

E. Section 07 92 00 - Joint Sealants: Sealing control and expansion joints.

1.3 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.

C. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction; 2022.

D. ASTM C55 - Standard Specification for Concrete Building Brick; 2023.

E. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units; 2023.

F. ASTM C91/C91M - Standard Specification for Masonry Cement; 2023.

G. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2018.

H. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.

I. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2018.

J. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.

K. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2018.

L. ASTM C476 - Standard Specification for Grout for Masonry; 2023.

M. ASTM C1634 - Standard Specification for Concrete Facing Brick and Other Concrete Masonry Facing Units; 2023a.

N. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry; 2019a.

O. ASTM E154/E154M - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover; 2008a (Reapproved 2019).

P. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2022, with Errata.

1.4 SUBMITTALS

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

B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.

C. Shop Drawings: Indicate pertinent dimensions, materials, anchorage, size and type of fasteners, and accessories for brickwork support system.

D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

E. Manufacturer's Qualification Statement.

1.5 QUALITY ASSURANCE

A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.

1.6 MOCK-UPS

A. Construct a full masonry wall as a mock-up panel sized 4 feet long by 4 feet high; include mortar, accessories, structural backup, and flashings (with lap joint, corner, and end dam) in mock-up.

B. Locate in an area that will not preclude concurrent work on the building shell..

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depths as indicated on drawings for specific locations.
   2. Load-Bearing Units: ASTM C90, normal weight.
      a. Hollow block, as indicated.
      b. Exposed Faces: Manufacturer's standard color and texture where indicated.

2.2 MORTAR AND GROUT MATERIALS

A. Masonry Cement: ASTM C91/C91M, Type N or Type S, dependent on use.

B. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.

C. Hydrated Lime: ASTM C207, Type S.

D. Mortar Aggregate: ASTM C144.

E. Grout Aggregate: ASTM C404.

F. Water: Clean and potable.

G. Accelerating Admixture: Nonchloride type for use in cold weather.

H. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
   1. Type: Type N.
   2. Color: Standard gray when below grade.

2.3 REINFORCEMENT AND ANCHORAGE

A. Manufacturers:
   1. Blok-Lok Limited: www.blok-lok.com/#sle.
   2. FERO Corporation: www.ferocorp.com/#sle.
   3. Hohmann & Barnard, Inc: www.h-b.com/#sle.
   4. TruFast Walls, a division of Altenloh, Brinck & Co. US, Inc; Thermal-Grip MVA: www.trufastwalls.com/#sle.
   5. WIRE-BOND: www.wirebond.com/#sle.
   6. Substitutions: See Section 01 60 00 - Product Requirements.

B. Reinforcing Steel: ASTM A615/A615M, Grade ~~40~~ 60 (~~40~~60,000 psi), ~~deformed billet bars; galvanized.~~

C. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
   1. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.

2. Wire ties: Manufacturer's standard shape, 0.1875 inch thick.
3. Vertical adjustment: Not less than 3-1/2 inches.

2.4 FLASHINGS

A. Metal Flashing Materials:
   1. Copper Flashing: ASTM B370, 060 soft annealed; 20 oz/sq ft thick; natural finish.

B. Combination Nonasphaltic Flashing Materials - Copper:
   1. Copper/Polymer Film or Fabric Flashing: 3 oz/sq ft copper sheet laminated between two sheets of polyethylene film. Minimum Puncture Resistance of 780 psi, when measured in accordance with ASTM E154/E154M.

C. Factory-Fabricated Flashing Corners and End Dams: To match flashing system..

D. Flashing Sealant/Adhesives: Silicone, polyurethane, or silyl-terminated polyether/polyurethane or other type required or recommended by flashing manufacturer; type capable of adhering to type of flashing used.

E. Termination Bars: Stainless steel; compatible with membrane and adhesives.

F. Drip Edge: Stainless steel; angled drip with hemmed edge; compatible with membrane and adhesives.
   1. Manufacturers:
      a. Hohmann & Barnard, Inc; _____: www.h-b.com/#sle.
      b. Mortar Net Solutions; Metal Drip Edges: www.mortarnet.com/#sle.
      c. York Manufacturing, Inc; _____: www.yorkmfg.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

G. Lap Sealants and Tapes: As recommended by flashing manufacturer; compatible with membrane and adhesives.

2.5 ACCESSORIES

A. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding; in maximum lengths available.
   1. Manufacturers:
      a. Hohmann & Barnard, Inc: www.h-b.com/#sle.
      b. WIRE-BOND: www.wirebond.com/#sle.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

B. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
   1. Mortar Diverter: Semi-rigid mesh designed for installation at flashing locations.

C. Drainage Fabric: Polyester or polypropylene mesh bonded to a water and vapor-permeable fabric.
   1. Manufacturers:
      a. Advanced Building Products, Inc;
         Mortairvent: www.advancedbuildingproducts.com/#sle.
      b. Mortar Net Solutions; DriPlane: www.mortarnet.com/#sle.

c. York Manufacturing, Inc; Weep Armor Weep Vent Protection: www.yorkmfg.com/#sle.
d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.6 MORTAR AND GROUT MIXING

A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
1. Masonry below grade and in contact with earth: Type S.
2. Exterior, loadbearing masonry: Type N.
3. Exterior, non-loadbearing masonry: Type N.
4. Interior, non-loadbearing masonry: Type O.

B. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

C. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Verify that related items provided under other sections are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.2 PREPARATION

A. Direct and coordinate placement of metal anchors supplied for installation under other sections.

B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.3 COLD AND HOT WEATHER REQUIREMENTS

A. Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

3.4 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Concrete Masonry Units:
1. Bond: Running.
2. Coursing: One unit and one mortar joint to equal 8 inches.

3. Mortar Joints: Flush.

3.5 PLACING AND BONDING

A. Lay hollow masonry units with face shell bedding on head and bed joints.

B. Remove excess mortar and mortar smears as work progresses.

C. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

D. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.6 WEEPS/CAVITY VENTS

A. Install weeps in veneer and cavity walls at 24 inches on center horizontally on top of through-wall flashing at bottom of walls.

3.7 CAVITY MORTAR CONTROL

A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.

B. For cavity walls, build inner wythe ahead of outer wythe to accommodate accessories.

C. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.8 REINFORCEMENT AND ANCHORAGE - SINGLE WYTHE MASONRY

A. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.

B. Place continuous joint reinforcement in first and second joint below top of walls.

C. Embed longitudinal wires of joint reinforcement in mortar joint with at least 5/8 inch mortar cover on each side.

D. Lap joint reinforcement ends minimum 6 inches.

E. Embed ties and anchors in mortar joint and extend into masonry unit a minimum of 1-1/2 inches with at least 5/8 inch mortar cover to the outside face of the anchor.

3.9 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

A. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches on center vertically and 24 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.

3.10 MASONRY FLASHINGS

A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.

1. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up flashing ends at least 1 inch, minimum, to form watertight pan at nonmasonry construction.
2. Remove or cover protrusions or sharp edges that could puncture flashings.
3. Seal lapped ends and penetrations of flashing before covering with mortar.

B. Terminate flashing up 8 inches minimum on vertical surface of backing:
1. Install vertical leg of flashing behind water-resistive barrier sheet over backing.
2. Anchor vertical leg of flashing into backing with a termination bar and sealant.

C. Install flashing in accordance with manufacturer's instructions and BIA Technical Notes No. 7.

D. Extend metal flashings to within 1/2 inch of exterior face of masonry and adhere to top of stainless steel angled drip with hemmed edge.

3.11 GROUTED COMPONENTS

A. Lap splices minimum 24 bar diameters.

B. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.

C. Place and consolidate grout fill without displacing reinforcing.

3.12 CONTROL AND EXPANSION JOINTS

A. Do not continue horizontal joint reinforcement through control or expansion joints.

B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

3.13 BUILT-IN WORK

A. As work progresses, install built-in metal door frames and glazed frames and other items to be built into the work and furnished under other sections.

B. Install built-in items plumb, level, and true to line.

C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.

3.14 TOLERANCES

A. Install masonry within the site tolerances found in TMS 402/602.

B. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.

C. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.15 CUTTING AND FITTING

A. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.16 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Control Services.

3.17 CLEANING

A. Remove excess mortar and mortar droppings.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution.

D. Use non-metallic tools in cleaning operations.

3.18 PROTECTION

A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION 04 20 00

SECTION 04 26 13
MASONRY VENEER

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Concrete facing brick.

B. Mortar and grout.

C. Reinforcement and anchorage.

D. Flashings.

E. Installation of lintels.

F. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 07 62 00 - Sheet Metal Flashing and Trim: Through-wall masonry flashings.

B. Section 07 92 00 - Joint Sealants: Sealing control and expansion joints.

1.3 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.

C. ASTM C55 - Standard Specification for Concrete Building Brick; 2023.

D. ASTM C91/C91M - Standard Specification for Masonry Cement; 2023.

E. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.

F. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2018.

G. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.

H. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2018.

I. ASTM C476 - Standard Specification for Grout for Masonry; 2023.

J. ASTM C1634 - Standard Specification for Concrete Facing Brick and Other Concrete Masonry Facing Units; 2023a.

K. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing; 2017.

L. BIA Technical Notes No. 28B - Brick Veneer/Steel Stud Walls; 2005.

M. BIA Technical Notes No. 46 - Maintenance of Brick Masonry; 2017.

N. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2022, with Errata.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene _____ before starting work of this section.

1.5 SUBMITTALS

A. See Section 01 33 00 Submittals, for submittal procedures.

B. Product Data: Provide data for masonry units, fabricated wire reinforcement, and mortar.

C. Samples: Submit four samples of decorative block units to illustrate color, texture, and extremes of color range.

D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.

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

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

1.7 MOCK-UP

A. Construct a masonry wall as a mock-up panel sized 4 feet long by 6 feet high; include mortar and accessories and structural backup in mock-up.

B. Locate where directed.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

B. Handle and store ceramic glazed masonry units in protective cartons or trays. Do not remove from protective packaging until ready for installation.

1.9 FIELD CONDITIONS

A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.

B. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.1 UNIT MASONRY - GENERAL

2.2 CONCRETE MASONRY UNITS

A. Concrete Facing Brick:
   1. Basis of Design Product: Oldcastle Architectural Cordova Stone
   2. Standard Size: 4" deep x 8" high x 24" long.
      a. Additional sizes may be used as required or indicated on drawings.
   3. Concrete Facing Brick: ASTM C1634; solid, medium weight; for architectural and below grade use.
      a. Exposed Faces, Color and Texture: Limestone, Chiselface.
      b. Lay Pattern: Running bond
      c. Manufacturers:
         1) Or approved substitution prior to bid.

2.3 MORTAR AND GROUT MATERIALS

A. Masonry Cement: ASTM C91/C91M Type N.

B. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.

C. Hydrated Lime: ASTM C207, Type S.

D. Grout Aggregate: ASTM C404.

E. Water: Clean and potable.

F. Accelerating Admixture: Nonchloride type for use in cold weather.

G. Packaged Dry Material for Morta for Unit

2.4 REINFORCEMENT AND ANCHORAGE

A. Reinforcing Steel: ASTM A615/A615M, Grade 40 (40,000 psi) yield strength, deformed billet bars; galvanized.

B. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
   1. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
   2. Wire ties: Manufacturer's standard shape, 0.1875 inch thick.
   3. Vertical adjustment: Not less than 3-1/2 inches.

2.5 FLASHINGS

A. Metal Flashing Materials: Copper, as specified in Section 07 62 00.

B. Metal Flashing Materials:

C. Combination Non-Asphaltic Flashing Materials - Copper:
   1. Copper/Polymer Film or Fabric Flashing: 3 oz/sq ft copper sheet laminated between two sheets of polymer or fiberglass fiber-reinforced film.
      a. Manufacturers:
         1) Advanced Building Products, Inc; _____: www.advancedbuildingproducts.com/#sle.
         2) Hohmann & Barnard, Inc; ____: www.h-b.com/#sle.
         3) York Manufacturing, Inc; Multi-Flash 500 Series: www.yorkmfg.com/#sle.
   2. Copper/Polymer Film or Fabric Flashing - Self-Adhering: 3 oz/sq ft copper sheet bonded on inward facing side to a sheet of polymer or fiberglass fabric that has a clear adhesive with a removable release liner.

D. Factory-Fabricated Flashing Corners and Ends: Stainless steel.
   1. Manufacturers:
      a. Hohmann & Barnard, Inc; ____: www.h-b.com/#sle.
      b. Mortar Net Solutions; CompleteFlash: www.mortarnet.com/#sle.
      c. York Manufacturing, Inc; _____: www.yorkmfg.com/#sle.

E. Flashing Sealant/Adhesives: Silicone, polyurethane, or silyl-terminated polyether/polyurethane, or other type required or recommended by flashing manufacturer; type capable of adhering to type of flashing used.
   1. Manufacturers, Synthetic Rubber Products:
      a. Mortar Net Solutions; BTL-1 Butyl Sealant: www.mortarnet.com/#sle.
   2. Manufacturers, Modified Polyether Products:
      a. Mortar Net Solutions; _____: www.mortarnet.com/#sle.
      b. York Manufacturing, Inc; UniverSeal US-100 Liquid Tape: www.yorkmfg.com/#sle.

F. Termination Bars: Stainless steel; compatible with membrane and adhesives.
   1. Manufacturers:
      a. Hohmann & Barnard, Inc; _____: www.h-b.com/#sle.
      b. Mortar Net Solutions; Termination Bars: www.mortarnet.com/#sle.
      c. York Manufacturing, Inc; _____: www.yorkmfg.com/#sle.

G. Drip Edge: Stainless steel; compatible with membrane and adhesives.
   1. Manufacturers:
      a. Hohmann & Barnard, Inc; _____: www.h-b.com/#sle.
      b. Mortar Net Solutions; Metal Drip Edges: www.mortarnet.com/#sle.
      c. York Manufacturing, Inc; _____: www.yorkmfg.com/#sle.

2.6 ACCESSORIES

A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
   1. Manufacturers:
      a. Blok-Lok Limited; _____: www.blok-lok.com/#sle.
      b. Hohmann & Barnard, Inc; _____: www.h-b.com/#sle.
      c. WIRE-BOND; _____: www.wirebond.com/#sle.

B. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding; in maximum lengths available.
   1. Manufacturers:
      a. Hohmann & Barnard, Inc; _____: www.h-b.com/#sle.
      b. WIRE-BOND; _____: www.wirebond.com/#sle.

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

C. Weeps:
1. Type: Extruded propylene with honeycomb design.
2. Color(s): As selected by Architect from manufacturer's full range.
3. Manufacturers:
a. Advanced Building Products, Inc; _____: www.advancedbuildingproducts.com/#sle.
b. Blok-Lok Limited; _____: www.blok-lok.com/#sle.
c. CavClear, a Division of Archovations Inc; _____: www.cavclear.com/#sle.
d. Hohmann & Barnard, Inc; _____: www.h-b.com/#sle.
e. Mortar Net Solutions; WeepVent: www.mortarnet.com/#sle.
f. WIRE-BOND; _____: www.wirebond.com/#sle.

D. Cavity Vents:
1. Type: Extruded propylene with honeycomb design.
2. Color(s): As selected by Architect from manufacturer's full range.
3. Manufacturers:
a. Advanced Building Products, Inc; _____: www.advancedbuildingproducts.com/#sle.
b. Blok-Lok Limited; _____: www.blok-lok.com/#sle.
c. CavClear, a Division of Archovations Inc; _____: www.cavclear.com/#sle.
d. Hohmann & Barnard, Inc; _____: www.h-b.com/#sle.

E. Drainage Fabric: Polyester mesh bonded to a water and vapor-permeable fabric.
1. Manufacturers:
a. Advanced Building Products, Inc; Mortairvent: www.advancedbuildingproducts.com/#sle.
b. Mortar Net Solutions; DriPlane: www.mortarnet.com/#sle.
c. York Manufacturing, Inc; Weep Armor Weep Vent Protection: www.yorkmfg.com/#sle.

F. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
1. Mortar Diverter: Panels installed at flashing locations.
a. Manufacturers:
1) Advanced Building Products, Inc; _____: www.advancedbuildingproducts.com/#sle.
2) CavClear, a Division of Archovations Inc; _____: www.cavclear.com/#sle.
3) Mortar Net Solutions; MortarNet: www.mortarnet.com/#sle.

G. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.7 MORTAR AND GROUT MIXING

A. Mortar for Unit Masonry: ASTM C270, Proportion Specification.
1. Masonry below grade and in contact with earth; Type S.
2. Exterior, non-loadbearing masonry; Type N.
3. Interior, non-loadbearing masonry; Type O.

B. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.

C. Grout: ASTM C476; consistency as required to fill volumes completely for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

D. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Verify that related items provided under other sections are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.2 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Concrete Facing Units:
   1. Bond: Running.
   2. Coursing: One unit and one mortar joint to equal 8 inches.
   3. Mortar Joints: Concave.

3.3 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.

B. Lay hollow masonry units with face shell bedding on head and bed joints.

C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.

D. Remove excess mortar as work progresses.

E. Interlock intersections and external corners.

F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

H. Isolate top joint of masonry veneer from horizontal structural framing members or support angles with compressible joint filler.

3.4 WEEPS/CAVITY VENTS

A. Install weeps in veneer walls at 24 inches on center horizontally on top of through-wall flashing above shelf angles and lintels and at bottom of walls.

B. Install cavity vents in veneer walls at 32 inches on center horizontally below shelf angles and lintels and at top of walls.

3.5 CAVITY MORTAR CONTROL

A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.

B. For cavity walls, build inner wythe ahead of outer wythe to accommodate accessories.

C. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.6 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

A. Install horizontal joint reinforcement 16 inches on center.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.

C. Place continuous joint reinforcement in first and second joint below top of walls.

D. Embed longitudinal wires of joint reinforcement in mortar joint with at least 5/8 inch mortar cover on each side.

E. Lap joint reinforcement ends minimum 6 inches.

F. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches on center vertically and 24 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.

3.7 MASONRY FLASHINGS

A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
   1. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up at least 1 inch, minimum, to form watertight pan at non-masonry construction.
   2. Remove or cover protrusions or sharp edges that could puncture flashings.
   3. Seal lapped ends and penetrations of flashing before covering with mortar.

B. Terminate flashing up 8 inches minimum on vertical surface of backing:
   1. Install vertical leg of flashing behind water-resistive barrier sheet over backing.
   2. Install vertical leg of flashing over fluid-applied or self-adhered air/vapor barriers over backing or per manufacturer's directions.
   3. Terminate vertical leg of flashing into bed joint in masonry or reglet in concrete.
   4. Anchor vertical leg of flashing into backing with a termination bar and sealant.
   5. Apply cap bead of sealant on top edge of self-adhered flashing.

C. Extend metal flashings through exterior face of masonry and terminate in an angled drip with hemmed edge. Install joint sealer below drip edge to prevent moisture migration under flashing.

D. Support flexible flashings across gaps and openings.

E. Extend plastic, laminated, and EPDM flashings to within 1/2 inch of exterior face of masonry and adhere to top of stainless steel angled drip with hemmed edge.

F. Lap end joints of flashings at least 6 inches, minimum, and seal watertight with flashing sealant/adhesive.

3.8 LINTELS

3.9 CONTROL AND EXPANSION JOINTS

A. Do not continue horizontal joint reinforcement through control or expansion joints.

B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

C. Size control joints as indicated on drawings; if not indicated, 3/4 inch wide and deep.

D. Form expansion joint as detailed on drawings.

3.10 TOLERANCES

A. Install masonry within the site tolerances found in TMS 402/602.

B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.

C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.

D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.

E. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.

F. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.

3.11 CUTTING AND FITTING

A. Cut and fit for pipes and conduit. Coordinate with other sections of work to provide correct size, shape, and location.

B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.12 CLEANING

A. Remove excess mortar and mortar smears as work progresses.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution.

D. Use non-metallic tools in cleaning operations.

3.13 PROTECTION

A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION 04 26 13

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Structural steel.
2. Grout.

B. Related Sections include the following:

1. Division 05 Section "Steel Decking" for field installation of shear connectors.
2. for surface preparation and priming requirements.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

1.4 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand ASD-service loads indicated and comply with other information and restrictions indicated.

1. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections.

B. Construction: Type restrained.

C. Construction: Type 2, simple framing.

1.5 ACTION SUBMITTALS

A. Shop Drawings:

1. Shop Drawings: Show fabrication of structural-steel components.

a. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
b. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

c. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
d. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:

1. Nonshrink grout.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CASE CSE.

B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Cbd Sbd.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 P2 P3 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

E. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
3. AISC's "Specification for the Design of Steel Hollow Structural Sections."

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.

1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.9 COORDINATION

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M and.

B. Channels, Angles-Shapes: ASTM A 36/A 36M .

C. Plate and Bar: ASTM A 36/A 36M.

D. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

1. Camber structural-steel members where indicated.
2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
3. Mark and match-mark materials for field assembly.
4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces.
2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.5 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances.[Prevent weld show-through on exposed steel surfaces.]

a. Grind butt welds flush.
b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.6 SHOP PRIMING

A. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

B. Painting: Apply a 1-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.7 GALVANIZING

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

1. Galvanize lintels attached to structural-steel frame and located in exterior walls.

2.8 SOURCE QUALITY CONTROL

A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

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

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

B. Base Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base plates. Clean bottom surface of base[and bearing] plates.

1. Set base plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of base plate.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and base plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

G. Do not use thermal cutting during erection.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design " for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances.

a. Grind butt welds flush.
b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories and abutting structural steel.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

END OF SECTION

SECTION 052100 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. K-series steel joists.
2. Joist accessories.

1.3 DEFINITIONS

A. SJI "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.

1.5 ACTION SUBMITTALS

A. Product Data with Shop Drawings:

1. Product Data: For each type of joist, accessory, and product indicated.
2. Shop Drawings: Show layout, designation, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, joist accessories; splice and connection locations and details; and attachments to other construction.

    a. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Manufacturer Certificates: Signed by manufacturers certifying that joists comply with requirements.

C. Mill Certificates: Signed by bolt manufacturers certifying that bolts comply with requirements.

D. Qualification Data: For manufacturer.

E. Field quality-control test and inspection reports.

F. Research/Evaluation Reports: For joists.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables of SJI "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. SJI Specifications: Comply with standard specifications in SJI's "Specifications" that are applicable to types of joists indicated.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel: Comply with SJI's "Specifications" for web and steel-angle chord members.

B. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.

D. Welding Electrodes: Comply with AWS standards.

E. Galvanizing Repair Paint: [MPI#18, MPI#19, or SSPC-Paint 20] [ASTM A 780].

2.2 PRIMERS

A. Primer: Provide shop primer that complies with Division 09 Section "High-Performance Coatings."

2.3 K-SERIES STEEL JOISTS

A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

C. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.

D. Provide holes in chord members for connecting and securing other construction to joists.

E. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."

F. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."

G. Camber joists according to SJI's "Specifications."

2.4 JOIST ACCESSORIES

A. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.

B. Bridging: Fabricate as indicated and according to SJI's "Specifications." Furnish additional erection bridging if required for stability.

C. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.

2.5 CLEANING AND SHOP PAINTING

A. Shop priming of joists and joist accessories is specified in Division 09 Section "High-Performance Coatings."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads have been applied.

C. Field weld joists to supporting steel framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.

E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.

F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect [field welds] [and] [bolted connections] and to perform field tests and inspections and prepare test and inspection reports.

B. Field welds will be visually inspected according to AWS D1.1/D1.1M.

C. In addition to visual inspection, field welds will be tested according to AWS D1.1/D1.1M and the following procedures, as applicable:

1. Radiographic Testing: ASTM E 94.
2. Magnetic Particle Inspection: ASTM E 709.
3. Ultrasonic Testing: ASTM E 164.
4. Liquid Penetrant Inspection: ASTM E 165.

D. Bolted connections will be visually inspected.

E. High-strength, field-bolted connections will be tested and verified according to procedures in RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."

F. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.

G. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

3.4 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Roof deck.

B. Related Sections include the following:

1. Division 05 Section "Structural Steel Framing" for shop- and field-welded shear connectors.

1.3 ACTION SUBMITTALS

A. Product Data with Shop Drawings:

1. Product Data: For each type of deck, accessory, and product indicated.
2. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of steel deck, signed by product manufacturer.

B. Welding certificates.

C. Field quality-control test and inspection reports.

D. Research/Evaluation Reports: For steel deck.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.

B. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

C. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

D. FMG Listing: Provide steel roof deck evaluated by FMG and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Steel Deck:

a. ASC Profiles, Inc.
b. Canam Steel Corp.;The Canam Manac Group.
c. Consolidated Systems, Inc.
d. DACS, Inc.
e. D-Mac Industries Inc.
f. Epic Metals Corporation.
g. Marlyn Steel Decks, Inc.
h. Metal Dek Group
i. New Millennium Building Systems, LLC.
j. Nucor Corp.; Vulcraft Division.
k. Roof Deck, Inc.
l. United Steel Deck, Inc.
m. Valley Joist; Division of EBSCO Industries, Inc.
n. Verco Manufacturing Co.
o. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

2.2 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

a. Color: Manufacturer's standard.

2. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade [33 (230)] [40 (275)] [80 (550)], G60 (Z180) zinc coating.
3. Deck Profile: As indicated.
4. Profile Depth: As indicated.

5. Span Condition: Triple span or more.

2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.

C. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

E. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

F. Galvanizing Repair Paint: ASTM A 780.

G. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:

1. Weld Diameter: 5/8 inch (16 mm), nominal.
2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 36 inches (910 mm), and as follows:

1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:

1. End Joints: Lapped 2 inches (51 mm) minimum or butted at Contractor's option.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. [Weld] [or] [mechanically fasten] to substrate to provide a complete deck installation.

E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Formed steel stud exterior wall framing.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wall sheathing.

B. Section 07 21 00 - Thermal Insulation: Insulation within framing members.

C. Section 07 25 00 - Weather Barriers: Water-resistive barrier over sheathing.

D. Section 07 92 00 - Joint Sealants.

E. Section 09 21 16 - Gypsum Board Assemblies: Cold-formed steel nonstructural framing.

F. Section 09 51 00 - Acoustical Ceilings: Ceiling suspension system.

1.3 DEFINITIONS

A. General: See AISI S240 for definitions of terms used in this section.

B. Connection: A combination of structural elements and joints used to transmit forces between two or more members.

C. Connector: A device used to transmit forces between cold-formed steel structural members or between a cold-formed steel structural member and another structural element.

1.4 REFERENCE STANDARDS

A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016, with Supplement (2020).

B. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015, with Errata (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 A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

E. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.

F. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.

G. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.

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

1.5 ADMINISTRATIVE REQUIREMENTS

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

1.6 SUBMITTALS

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

B. Product Data: Provide data on cold-formed steel structural members; include material descriptions, base steel thickness, corrosion protection, and dimensions.

C. Product Data: Provide manufacturer's data on factory-made connectors and mechanical fasteners, showing compliance with requirements.

D. Product Data: For lateral-force resisting systems, provide product data sheets on hold-down, showing compliance with requirements.

E. Shop Drawings: Indicate component details, bearing, anchorage, loading, and type and location of fasteners, and accessories or items required of related work.
   1. Indicate stud layout.

F. Steel Framing Industry Association (SFIA) Certification:
   1. Submit documentation that metal studs and connectors used on project meet or exceed requirements of International Building Code.

G. Design Data:
   1. Shop drawings signed and sealed by a professional structural engineer.
   2. Design calculations sufficient to demonstrate compliance with design criteria; signed and sealed by a professional structural engineer.
   3. Details and calculations for factory-made connectors, signed and sealed by a professional structural engineer.

H. Evaluation Service Reports: Provide reports indicating compliance with specified requirements for cold-formed steel structural members.

I. Inspection Reports: Provide Inspection Reports for welding, mechanical fastening, and cold-formed steel light-frame construction in accordance with requirements of AISI S240.

J. Manufacturer's Installation Instructions: Provide installation instructions for connectors.

K. Manufacturer's Installation Instructions: For lateral-force resisting systems, indicate welding procedure specifications.

L. Installation Drawings: Indicate dimensioned locations of cold-formed steel structural framing.
   1. Include materials.

M. Designer's Qualification Statement.

N. Manufacturer's Qualification statement.

1.7 QUALITY ASSURANCE

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

B. Designer Qualifications: Design framing system under direct supervision of a professional structural engineer experienced in designing this work and licensed in Ohio.

C. SFIA Code Compliance Certification Program: www.CFsteel.org/#sle: Use metal studs and connectors certified for compliance with International Building Code.

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

E. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Structural Framing:
   1. ClarkDietrich: www.clarkdietrich.com/#sle.
   2. Jaimes Industries: www.jaimesind.com/#sle.
   3. MarinoWARE: www.marinoware.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Connectors:
   1. Same manufacturer as metal framing.

2.2 PERFORMANCE REQUIREMENTS

A. Design Requirements: Design cold-formed framing systems, components and connectors to withstand specified design loads in compliance with ICC (IBC), ASCE 7, AISI S100, and AISI S240.

B. Design Criteria: In accordance with applicable codes.
   1. Live load deflection meeting the following, unless otherwise indicated:
      a. Exterior Walls: Maximum horizontal deflection under wind load of 1/180 of span.
   2. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
   3. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

2.3 MATERIALS

A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.
   1. Structural Grade: As required to meet design criteria.
   2. Corrosion Protection Coating Designation: CP 60 in accordance with AISI S240.

2.4 STRUCTURAL FRAMING COMPONENTS

A. Wall Studs and Track Sections: AISI S240; c-shaped studs and u-shaped track sections in stud-matching nominal width and compatible height.
   1. Thickness and Depth: Depth as indicated on the drawings; thickness and structural grade as required to meet design criteria.
   2. Provide components fabricated from ASTM A1011/A1011M Designation SS (structural steel).

2.5 LATERAL FORCE-RESISTING SYSTEMS

A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.
   1. Structural Grade: As required to meet design criteria.
   2. Corrosion Protection Coating Designation: CP 60 in accordance with AISI S240.

B. Curtain Wall Studs and Girts:
   1. Thickness and Depth: Depth as indicated on the drawings; thickness and structural grade as required to meet design criteria.

2.6 CONNECTIONS

A. Performance Requirements: Provide connections in compliance with requirements of AISI S240.

B. Structural Performance: Maintain load and movement capacity required by applicable building code and specified design criteria.

2.7 MISCELLANEOUS CONNECTIONS

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

B. Anchorage Devices: Powder actuated.

2.8 ACCESSORIES

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

B. Galvanizing Repair: Touch up bare steel with zinc-rich paint in compliance with ASTM A780/A780M.

C. Water-Resistive Barrier: See Section 07 25 00.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Verify field measurements and adjust installation as required.

3.2 PREPARATION

A. Structural Wall Foundations: For gaps between wall bottom track and top of foundation 1/4 inch or greater, level substrate with loadbearing shims or grout between track and foundation.

3.3 INSTALLATION - GENERAL

A. Install structural members and connections in compliance with ASTM C1007.

3.4 INSTALLATION OF STUDS

A. Install wall studs plumb and level.

B. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.

C. Install load-bearing studs full length in one piece. Splicing of studs is not permitted.

D. Install load-bearing studs; brace, and reinforce to develop full strength and achieve design requirements.

E. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.

F. Install intermediate studs above and below openings to align with wall stud spacing.

G. Provide deflection allowance in stud track, directly below horizontal building framing at non-loadbearing framing.

H. Attach cross studs to studs for attachment of fixtures anchored to walls.

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

J. Touch-up field welds and damaged corrosion-protected surfaces zinc-rich paint in compliance with ASTM A780/A780M.

K. Touch-up field welds and damaged corrosion protected surfaces with primer.

3.5 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Control Services, for additional requirements.

B. Provide inspections for mechanical fastening and cold-formed steel light-frame construction in accordance with requirements of AISI S240.

3.6 TOLERANCES

A. Studs - Vertical Alignment (Plumbness): 1/960 of span or 1/8 inch in 10 ft, in accordance with ASTM C1007.

B. Studs - Maximum Variation from True Position: 1/8 inch in accordance with ASTM C1007.

END OF SECTION 05 40 00

SECTION 05 51 33
METAL LADDERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Shop-fabricated metal ladders.

1.2 RELATED REQUIREMENTS

A. Section 05 52 13 - Pipe and Tube Railings.

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

1.3 REFERENCE STANDARDS

A. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements; 2008 (Reaffirmed 2018).

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

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

D. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.

E. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.

F. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.

G. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.

H. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

I. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.

J. SSPC-SP 2 - Hand Tool Cleaning; 2018.

1.4 SUBMITTALS

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

B. Shop Drawings:
   1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
   2. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

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.

1.5 QUALITY ASSURANCE

A. Design ladders under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in Ohio.

PART 2 PRODUCTS

2.1 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 or compatible with materials being fastened; type consistent with design and specified quality level.

F. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

G. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2.2 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

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

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

2.3 FABRICATED LADDERS

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

4. Provide Bilco "Ladder Up" safety post or similar device at the top of any ladder that does not allow for handrail extensions such as at roof hatches.

2.4 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. 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.

2.5 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

3.1 EXAMINATION

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

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.3 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. Field weld components as indicated on drawings.

D. Perform field welding in accordance with AWS D1.1/D1.1M.

E. Obtain approval prior to site cutting or making adjustments not scheduled.

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

3.4 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 05 52 13
PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Mechanical platform railings and guardrails.

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

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

B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

C. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.

D. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.

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

F. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.

G. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.

H. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

I. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.4 SUBMITTALS

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

B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.
   1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   2. Include the design engineer's seal and signature on each sheet of shop drawings.

C. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated within the previous 12 months.

D. Designer's Qualification Statement.

E. Fabricator's Qualification Statement.

1.5 QUALITY ASSURANCE

A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in Ohio, or personnel under direct supervision of such an engineer.

B. Welder Qualifications: Welding processes and welding operators qualified within previous 12 months.

C. Fabricator Qualifications:
   1. A company specializing in manufacturing products specified in this section, with not less than five years of documented experience.

PART 2 PRODUCTS

2.1 RAILINGS - GENERAL REQUIREMENTS

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

B. Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 75 pounds per linear foot applied to the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935

C. Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds applied at any point on the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935

D. Allow for expansion and contraction of members and building movement without damage to connections or members.

E. Dimensions: See drawings for configurations and heights.
   1. Top Rails: 1-1/2 inches diameter, round.
   2. Posts: 1-1/2 inches diameter, round.

F. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
   1. For anchorage to concrete, provide inserts to be cast into concrete, for welding anchors.

G. Provide welding fittings to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.

H. Welded and Brazed Joints: Make visible joints butt tight, flush, and hairline; use methods that avoid discoloration and damage of finish; grind smooth, polish, and restore to required finish.
   1. Ease exposed edges to a small uniform radius.
   2. Welded Joints:
      a. Carbon Steel: Perform welding in accordance with AWS D1.1/D1.1M.

2.2 STEEL RAILING SYSTEM

A. Steel Tube: ASTM A500/A500M Grade B cold-formed structural tubing.

B. Steel Pipe: ASTM A53/A53M Grade B Schedule 80, black finish.

C. Non-Weld Mechanical Fittings: Slip-on, galvanized malleable iron castings, for Schedule 40 pipe, with flush setscrews for tightening by standard hex wrench, no bolts or screw fasteners.

D. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.

E. Exposed Fasteners: No exposed bolts or screws.

F. Galvanizing: In accordance with requirements of ASTM A123/A123M.
   1. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20 Type I - Inorganic.

2.3 FABRICATION

A. Accurately form components to suit specific project conditions and for proper connection to building structure.

B. Fit and shop assemble components in largest practical sizes for delivery to site.

C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.

D. Welded Joints:
   1. Interior Components: Continuously seal joined pieces by intermittent welds and plastic filler.
   2. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Weld connections that cannot be shop welded due to size limitations.
   1. Weld in accordance with AWS D1.1/D1.1M.
   2. Match shop welding and bolting.
   3. Clean welds, bolted connections, and abraded areas.
   4. Touch up shop primer and factory-applied finishes.
   5. Repair galvanizing with galvanizing repair paint per ASTM A780/A780M.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

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

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.

C. Anchor railings securely to structure.

D. Field weld anchors as indicated on shop drawings. Touch-up welds with primer. Grind welds smooth.

3.4 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per floor level, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 05 52 13

SECTION 055300 - METAL GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal bar gratings.

B. Related Sections:

1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1.4 ACTION SUBMITTALS

A. Product Data with Shop Drawings:

1. Product Data: For the following:

a. Formed-metal plank gratings.
b. Extruded-aluminum plank gratings.
c. Glass-fiber-reinforced plastic gratings.
d. Clips and anchorage devices for gratings.
e. Paint products.

2. Shop Drawings: Include plans, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 FERROUS METALS

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

B. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

C. Wire Rod for Bar Grating Crossbars: ASTM A 510 (ASTM A 510M).

2.2 FASTENERS

A. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

B. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).

2.3 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.

2.4 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates to fit grating units and weld to units in shop unless otherwise indicated.
2. Fabricate toeplates for attaching in the field.
3. Toeplate Height: 4 inches (100 mm) unless otherwise indicated.

2.5 METAL BAR GRATINGS

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

1. Alabama Metal Industries Corporation; a Gibraltar Industries company.
2. All American Grating.
3. BarnettBates Corporation.
4. Borden Metal Products (Canada) Limited.
5. Fisher & Ludlow; Division of Harris Steel Limited.
6. Grating Pacific, Inc.
7. Grupo Metelmex, S.A. de C.V.
8. IKG Industries; a division of Harsco Corporation.
9. Marwas Steel Co.; Laurel Steel Products Division.
10. Ohio Gratings, Inc.
11. Seidelhuber Metal Products; Division of Brodhead Steel Products.

2.6 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches (32 mm) wide by 1/4 inch (6 mm) thick by 8 inches (200 mm) long.

2.7 STEEL FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish gratings, frames, and supports after assembly.

C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

D. Shop prime gratings, frames and supports not indicated to be galvanized unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

E. Attach toeplates to gratings by welding at locations indicated.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 INSTALLING EXPANDED-METAL GRATINGS

A. General: Comply with manufacturer's written instructions for installing gratings.

B. Place units with straight edge of bond up and with long direction of diamond-shaped openings parallel to direction of span.

C. Attach nonremovable units to supporting members by welding unless otherwise indicated. Space welds at 6-inch (150-mm) intervals.

D. Butt edges parallel to long direction of diamond-shaped openings and weld at every second bond point. Place individual grating sections so diamonds of one piece are aligned with those of adjacent sections.

END OF SECTION

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Rough opening framing for doors, windows.

B. Sheathing.

C. Micellaneous rough carpentry.

D. Miscellaneous framing and sheathing.

E. Concealed wood blocking, nailers, and supports.

F. Miscellaneous wood nailers, furring, and grounds.

1.2 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. ASTM C557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing; 2003 (Reapproved 2017).

C. ASTM E2357 - Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies; 2023a.

D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).

E. AWPA U1 - Use Category System: User Specification for Treated Wood; 2023.

F. ICC-ES AC310 - Acceptance Criteria for Water-Resistive Membranes Factory-Bonded to Wood-Based Structural Sheathing, Used as Water-Resistive Barriers; 2008, with Editorial Revision (2021).

G. PS 2 - Performance Standard for Wood Structural Panels; 2018.

H. PS 20 - American Softwood Lumber Standard; 2021.

1.3 WARRANTY

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

PART 2 PRODUCTS

2.1 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.
3. Lumber of other species or grades is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.

B. Provide sustainably harvested wood; see Section 01 60 00 - Product Requirements for requirements.

C. Provide wood harvested within a 500 mile radius of the project site.

D. Lumber salvaged from deconstruction or demolition of existing buildings or structures is permitted in lieu of sustainably harvested lumber provided it is clean, denailed, and free of paint and finish materials, and other contamination; identify source.
1. Where salvaged lumber is used for structural applications, provide lumber re-graded by an inspection service accredited by the American Lumber Standard Committee, Inc; www.alsc.org.

E. Lumber fabricated from recovered timber is permitted in lieu of sustainably harvested lumber, unless otherwise noted, provided it meets the specified requirements for new lumber and is free of contamination; identify source.

2.2 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

A. Sizes: Nominal sizes as indicated on drawings, S4S.

B. Moisture Content: S-dry or MC19.

2.3 CONSTRUCTION PANELS

A. Wall Sheathing: Oriented strand board structural wood panel with factory laminated water-resistive barrier layer.
1. Sheathing Panel: PS 2, Exposure 1.
   a. Size: 4 feet wide by 8 feet long.
   b. Grade: Sheathing.
   c. Performance Category: 7/16 PERF CAT.
   d. Span Rating: 24/16.
   e. Edge Profile: Square edge.
2. Integral Water-Resistive Barrier: Sheet material qualifying as a Grade D water-resistive barrier; complying with ICC-ES AC310.
3. Water Vapor Permeance of Water-Resistive Barrier: 12 to 16 perms, minimum, when tested in accordance with ASTM E96/E96M Procedure B.
4. Maximum Allowable Air Leakage of Assembly: Comply with ASTM E2357.
   a. Infiltration: 0.0072 cfm/sq ft, maximum, at a pressure differential of 1.57 psf.
   b. Exfiltration: 0.0023 cfm/sq ft, maximum, at a pressure differential of 1.57 psf.
5. Provide fastening guide on top panel surface with separate markings indicating fastener spacing for 16 inches and 24 inches on center, respectively.
6. Seam Tape: Manufacturer's standard pressure-sensitive, self-adhering, cold-applied, seam tape.
7. Warranty: Manufacturer's standard 30 year limited system warranty.
   a. Performance: Panel and tape resistance to water penetration; tape adhesion.

b. Material: Free from manufacturing defects and panel delamination.

8. Manufacturers:
   a. Georgia-Pacific LLC; ForceField Air and Water Barrier System: www.buildgp.com/#sle.
   b. Huber Engineered Woods, LLC; ZIP System Roof/Wall Sheathing and ZIP System Seam Tape: www.huberwood.com/#sle.
   c. Louisiana-Pacific Corporation; WeatherLogic: www.lpcorp.com/#sle.
   d. Substitutions: See Section 01 60 00 - Product Requirements.

2.4 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. Drywall Screws: Bugle head, hardened steel, power driven type, length three times thickness of sheathing.
   3. Anchors: Toggle bolt type for anchorage to hollow masonry.

B. General Purpose Construction Adhesives: Comply with ASTM C557.

2.5 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.
   2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 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.

3.3 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. Provide the following specific nonstructural framing and blocking:
   1. Cabinets and shelf supports.
   2. Wall brackets.
   3. Handrails.
   4. Grab bars.
   5. Towel and bath accessories.
   6. Wall-mounted door stops.
   7. Visual display boards
   8. Wall paneling and trim.
   9. Joints of rigid wall coverings that occur between studs.
   10. As indicated on drawings. .
   11. Owner provided, wall mounted equipment and accessories. .

3.4 INSTALLATION OF CONSTRUCTION PANELS

A. Wall Sheathing and Roof Sheathing with Laminated Water-Resistive Barrier and Air Barrier: Secure to studs in accordance with manufacturer's installation instructions.
   1. Install with laminated water-resistive and air barrier on exterior side of sheathing.
   2. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
   3. Use only mechanically attached and drainable EIFS and exterior insulation with wall sheathing with laminated water-resistive and air barrier.
   4. Apply manufacturer's standard seam tape to joints between sheathing panels; use tape gun or hard rubber roller in accordance with manufacturer's installation instructions.

3.5 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 00
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Specially fabricated cabinet units.

B. Hardware.

C. Shelving End Panels

D. Preparation for installing utilities.

1.2 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 12 36 00 - Countertops.

1.3 REFERENCE STANDARDS

A. ANSI A208.1 - American National Standard for Particleboard; 2022.

B. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.

C. AWI (QCP) - Quality Certification Program; Current Edition.

D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

E. AWMAC (GIS) - Guarantee and Inspection Services Program; Current Edition.

F. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

G. BHMA A156.9 - Cabinet Hardware; 2020.

H. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

I. WI (CCP) - Certified Compliance Program (CCP); Current Edition.

1.4 SUBMITTALS

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

B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
   2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

C. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet, countertop, and shelf unit substrate and finish.

D. Samples: Submit actual sample items of proposed pulls, hinges, shelf standards, and locksets, demonstrating hardware design, quality, and finish.

E. Sustainable Design Submittal: Documentation for sustainably harvested wood-based components.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
   1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
   2. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
   3. Single Source Responsibility: Provide and install this work from single fabricator.

B. Quality Certification:
   1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
   2. Comply with AWMAC (GIS) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awmac.com/#sle.
   3. Comply with WI (CCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: https://woodworkinstitute.com/#sle.
   4. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
   5. Provide designated labels on shop drawings as required by certification program.
   6. Provide designated labels on installed products as required by certification program.
   7. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.
   8. Replace, repair, or rework all work for which certification is refused.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect units from moisture damage.

1.7 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

2.1 CABINETS

A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

B. Plastic Laminate Faced Cabinets: Custom grade.

C. Cabinets:
   1. Grained Face Layout for Cabinet and Door Fronts: Style and Rail, all Grades.
      a. Provide well-matched doors, drawer fronts and false fronts across multiple abinet faces in one elevation.
      b. Drawer fronts: Vertical grain, u.n.o. on drawings.
      c. Doors: Vertical grain.
   2. Interior Finish - Exposed Interior Surfaces: Match door fronts.
   3. Interior Finish - Concealed Surfaces: Thermoset decorative panels.
   4. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
   5. Adjustable Shelf Loading: 40 psf.
      a. Deflection: L/144.
   6. Cabinet Style: Flush overlay.
   7. Cabinet Doors and Drawer Fronts: Flush style.
   8. Drawer Side Construction: Manufacturer's option.
   9. Drawer Construction Technique: As recommended by fabricator.

2.2 WOOD-BASED COMPONENTS

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

2.3 PANEL CORE MATERIALS

A. Particleboard: Composite panel composed of cellulosic particles, additives, and bonding system; comply with ANSI A208.1.
   1. Grade: M-2; moisture resistance: MR10.
   2. Panel Thickness: 1/2 inch.

2.4 LAMINATE MATERIALS

A. Manufacturers:
   1. Formica Corporation: www.formica.com/#sle.
   2. Wilsonart LLC: www.wilsonart.com/#sle.
   3. Laminart.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.

C. Provide specific types as indicated.
   1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, through color, colors as indicated, finish as indicated.
   2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, through color, colors as indicated, finish as indicated.
   3. Cabinet Liner: CLS, 0.020 inch nominal thickness, through color, colors as indicated, finish as indicated.
   4. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.
   5. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and same finish as cabinetry.

D. Basis of Design Color Selections:
   1. PL-01 - Wilsonart Frosty White 1573-60 (Matte)

2. PL-02 - Wilsonart Wood Grain (Matte)
3. PL-03 - Wilsonart XXX (Matte)

2.5 COUNTERTOPS

A. Countertops: See Section 12 36 00.

2.6 ACCESSORIES

A. Adhesive: Type recommended by fabricator to suit application.

B. Plastic Edge Banding: Extruded PVC, convex shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
   1. Color: As selected by Architect from manufacturer's full range.

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: Standard plastic or painted metal grommets for cut-outs, in color to match adjacent surface.

2.7 HARDWARE

A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.

B. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, satin chrome finish, for nominal 1 inch spacing adjustments.

C. Product: 282.40.708 manufactured by Hafele America Co.

D. Countertop Support Brackets: Fixed, L-shaped, face-of-stud mounting.
   1. Materials: Steel; T-shape cross-section.
      a. Finish: Manufacturer's standard, factory-applied, powder coat.
      b. Color: As selected by Architect from manufacturer's full range. .
      c. Height: 9 inches.
      d. Support Length: 9 inches.
      e. Width: 1 inch.

E. Vanity Brackets: Fixed, ADA-compliant, face-of-stud mounting.
   1. Material and Shape: Steel; formed compound shapes.
      a. Finish: Manufacturer's standard, factory-applied, textured powder coat.
      b. Color: Black.
   2. Height: 18 inches.
   3. Support Length: 21-1/2 inches.

F. Vanity Brackets: Cantilevered support leg, face-of-stud mounting.
   1. Materials: Steel T-shapes.
   2. Finish: Manufacturer's standard, factory-applied, powder coat.

3. Color: White.
4. Support Length: 9 inches.

G. Drawer and Door Pulls: "U" shaped wire pull, aluminum with satin finish, 4 inch centers.

H. Keyed Cabinet Locks: Keyed cylinder, two (2) keys per lock, master keyed, steel with satin finish.
1. Provide locks on every door and drawer.
2. Provide a minimum of six (6) master keys.

I. Cabinet and Drawer Catches and Latches:
1. Type: Push latch with magnet.

J. Drawer Slides:
1. Type: Full extension.
2. Static Load Capacity: As required by drawer size.
3. Mounting: Side mounted.
4. Stops: Integral type.
5. Features: Provide self closing/stay closed type.
6. Manufacturers:
a. Accuride International, Inc www.accuride.com/#sle.
b. Knape & Vogt Manufacturing Company: www.knapeandvogt.com/#sle.

K. Hinges: European style concealed self-closing type, steel with satin finish.

L. Chain Stops: Provide chain stops at all doors that open adjacent to a perpendicular surface.

2.8 FABRICATION

A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.

C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
1. 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. Matching Wood Grain: Comply with requirements of quality standard for specified Grade and as follows:
1. Provide center matched panels at each elevation.
2. Provide sequence matching across each elevation.

F. Provide cutouts for plumbing fixtures, inserts, outlet boxes, and fixtures and fittings. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

2.9 SHOP FINISHING

A. Sand work smooth and set exposed nails and screws.

B. For opaque finishes, apply wood filler in exposed nail and screw indentations and sand smooth.

C. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify location and sizes of utility rough-in associated with work of this section.

3.2 INSTALLATION

A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

B. Use fixture attachments in concealed locations for wall mounted components.

C. Use concealed joint fasteners to align and secure adjoining cabinet units.

D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.

E. Secure cabinets to floor using appropriate angles and anchorages.

F. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.3 ADJUSTING

A. Adjust installed work.

B. Adjust moving or operating parts to function smoothly and correctly.

3.4 CLEANING

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

END OF SECTION 06 41 00

SECTION 06 42 00
WOOD PANELING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Shop finishing.

B. Wood Veneer Plywood

1.2 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 09 93 00 - Staining and Transparent Finishing: Field finishing.

1.3 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

C. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

D. AWPA U1 - Use Category System: User Specification for Treated Wood; 2023.

E. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2020.

1.4 SUBMITTALS

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

B. Product Data: Provide data on fire-retardant treatment materials and application instructions.

C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Provide plan of panel number sequencing.
   2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

D. Samples: Submit two samples of finished plywood, ____x____ inch in size, illustrating wood grain and specified finish.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect work from moisture damage.

B. Do not deliver wood materials to project site until building is fully enclosed and interior temperature and humidity are in accordance with recommendations of AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

PART 2 PRODUCTS

2.1 PANELING

A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless otherwise indicated.

B. Flat Paneling:
   1. Species: Birch.
   2. Cut: Plain sawn.
   3. Panels: Veneer of full width and balanced sequence matched.
   4. Visible Edges and Reveals: Filled and stained.
   5. Outside Corners: Mitered and splined.

2.2 WOOD-BASED MATERIALS - GENERAL

A. Hardwood Plywood: HPVA HP-1 Grade A; veneer core, type of glue recommended for application; of grain quality suitable for transparent finish.

2.3 ADHESIVES AND FASTENERS

A. Adhesives: Type suitable for intended purpose, complying with applicable air quality regulations.

B. Fasteners: Of size and type to suit application; Aluminum finish in concealed locations and Brass finish in exposed locations.

2.4 FABRICATION

A. Prepare panels for delivery to site, permitting passage through building openings.

B. Finish exposed edges of panels as specified by grade requirements.

2.5 SHOP FINISHING

A. Sand work smooth and set exposed nails and screws.

B. Apply wood filler in exposed nail and screw indentations.

C. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
   1. Transparent:
      a. System - 1, Lacquer, Nitrocellulose.
      b. Stain: As selected by Architect.
         1) Sherwin Williams - Classic Wood Stain. Reference drawings for stain color.
      c. Sheen: Flat.

PART 3 EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION

A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.

B. Do not begin installation until wood materials have been fully acclimated to interior conditions.

C. Set and secure materials and components in place, plumb and level, using concealed fasteners wherever possible.

D. Where necessary to cut and fit on site, scribe work abutting other components. Do not use additional overlay trim to conceal gaps.

E. Touch up damaged finish to match original, using materials provided by fabricator; replace components that cannot be refinished like new.

END OF SECTION 06 42 00

SECTION 070523 - PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS

PART 1 - GENERAL

1.1 SUMMARY

A. This testing activity shall be in accordance with this specification section and ASTM E779 "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization". In addition to air leakage testing, Thermography services shall also be performed, giving a qualitative inspection of the building's air and thermal barriers to identify areas of thermal bridging, compromised insulation, potential moisture intrusion and air leakage pathways. The Thermographic Inspection will be conducted in accordance with ASTM C 1060, and ASTM E 1186. Test results and recommendations for corrective measures will also be provided in a final report.

B. Testing to be provided, scheduled, and coordinated with sub-contractors per project specifications. Commissioning Agent shall provide a certified Building Envelope Commissioning Agent, BECx, and owns and operates the required Orifice Blower Doors.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced within the text by the basic designation only.

B. ASTM INTERNATIONAL (ASTM)

1. ASTM E283 "Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen."

2. ASTM E779 (2019) Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

3. ASTM E1186 (2017) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems

4. ASTM E1827 (2011; R 2017) Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door

5. ASTM C1060 "Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings."

C. Related Sections: Performance requirements for exterior enclosure components are included, but not limited to the following sections:

1. Section 01 91 00 "General Commissioning Requirements."

2. Section 01 91 18 "Commissioning of Building Envelope Systems."

3. Section 07 – Specification Sections relating to exterior wall and roof assemblies.

4. Section 08 – Specification Sections relating to exterior doors, curtain walls / storefronts, glazing, windows, skylights, louvers & vents.

5. Section 22 08 00 "Commissioning of Plumbing Systems"

6. Section 23 08 00 "Commissioning of HVAC Systems"

7. Section 26 08 00 "Commissioning of Electrical Systems"

1.3 DEFINITIONS

A. The following terms as they apply to this section:

1. Air Barrier Envelope

a. The surface that separates the inside air from the outside air. The combination of air barrier assemblies and air barrier components, connected by air barrier accessories are designed to provide a continuous barrier to the movement of air through an environmental separator. A single building may have more than one air barrier envelope. The air barrier surface includes the top, bottom, and sides of the envelope. The term "air barrier envelope" is also known as "air barrier system" or simply "air barrier".

2. Air Leakage Rate

a. How leaky, or conversely how air tight a building envelope is. The air leakage is normally described in terms of air flow rate for the surface area of the envelope at a defined differential pressure.

3. Bias Pressure

a. Also known as zero flow pressure, baseline pressure, offset pressure or background pressure. With the envelope not artificially pressurized, bias is the differential pressure that always exists between the envelope that has been prepared (sealed) for the pressure test and the outdoors. Bias pressure is made up of two components, fixed static offset (usually due to stack effect or the HVAC system) and fluctuating pressure (usually due to wind or a moving elevator). Because of pressure fluctuations many bias pressure readings are recorded and averaged for use in the calculations.

4. Blower Door

a. Commonly used term for an apparatus used to pressurize and depressurize the space within the building envelope and quantify air leakage through the envelope. The blower door typically includes a door fan and an air resistant fabric or a series of hard panels that extends to cover and seal the door opening between the fan shroud and door frame. The door fan is a calibrated fan capable of measuring air flow and is usually placed in the opening of an exterior door. With the air barrier otherwise sealed, air produced by the door fan pressurizes or de-pressurizes the envelope, depending on the fan's orientation.

5. Environmental Separator

a. The parts of a building that separate the controlled interior environment from the uncontrolled exterior environment, or that separate spaces within a building that have dissimilar environments. The term "environmental separator" is also known as the "control layer".

6. Pressure Test

a. A generic term for a test in which the envelope is either pressurized or de-pressurized with respect to the outdoors.

7. Negative Pressure Test (Depressurization Test)

a. A test wherein air inside the envelope is drawn to the outdoors. This places the envelope at a lower (negative) pressure with respect to the outdoors.

8. Positive Pressure Test (Pressurization Test)

a. A test wherein outdoor air is pushed into the envelope. This air movement places the envelope at a higher (positive) pressure with respect to the outdoors.

1.4 WORK PLAN (PRESSURE TEST PLAN)

A. Submit the following not later than [120] calendar days after contract award, but before start of pressure testing work, steps to be taken by the lead pressure test technician to accomplish the required testing.

1. Memorandum of test procedure.

a. Proposed dates for conducting the pressure, thermographic and/or fog tests.

b. Submit detailed pressure test procedures prior to the test.

c. Provide a plan view showing proposed locations (personnel doors or other similar openings) to install blower doors or flexible ducts (for trailer-mounted fans), if used. Include means of providing power to test fan assemblies.

2. Test equipment to be used.

3. Scaffolding, scissor lifts, power, electrical extension cords, duct tape, plastic sheeting and other Contractor's support equipment required to perform all tests.

4. Other Contractor's support personnel who will be on site for testing.

1.5 SUBMITTALS

1.6 Shop Drawing Submittals:

A. The shop drawings for exterior enclosure work for the entire project shall be combined into a single submission and shall include scheduling to indicate all exterior enclosure work to be completed prior to envelope pressure testing and before drywall completion to facilitate the improvement of leakage areas found.

1.7 Product Data Submittals:

A. Submit manufacturer's specifications and installation instructions for each exterior enclosure component/assembly specified (all components which comprise exterior wall and roof types/assemblies). Include product test reports.

1.8 QUALITY ASSURANCE

A. Qualifications

1. Pressure Test Agency

a. The work of the test agency is limited to pressure testing the building envelope, performing a thermography test and/or fog test, and investigating, through various methods, the location of air leaks through the air barrier.

b. The testing agency shall submit the following information.

1) Verification of 3 years of experience as an agency in pressure testing commercial and/or industrial buildings.

2) List of at least 5 commercial/industrial facilities with building envelopes that the agency has tested within the past 3 years. Include building name, address, and name of prime construction contractor and contractor's point-of-contact information.

3) Confirmation of 3 years of commercial and or industrial building pressure test experience for the lead pressure test technician and the thermographer in using the specified ASTM E779 testing standard. References from three owner representatives or architects where the lead test technician has supervised commercial and or industrial building pressure tests in the last 3 years.

2. Thermographer Qualifications

a. For infrared diagnostic evaluations, use a lead thermographer who is specifically focused on infrared thermography for building science. The thermographer must have at least 3 years of building science thermography experience in IR testing commercial or industrial buildings. The thermographer must also have experience in building envelopes and building science in order to make effective recommendations to the contractor should the envelope require additional sealing.

b. Submit a list of at least 5 commercial/industrial buildings on which the thermographer has performed IR thermography in the past 3 years.

3. Test Instruments and Date of Last Calibration

a. Submit a signed and dated list of test instruments, their application, manufacturer, model, serial number, range of operation, accuracy, and date of most recent calibration. Calibration data applicable to fan systems must be in accordance with ASTM E1258.

4. Test Reports

a. No later than 14 days after completion of the pressure test, submit electronic copies of an organized report. The report is to contain a table of contents, an executive summary, an introduction, a results section, and a discussion of the results. Submit the air leakage test report as described in paragraph AIR LEAKAGE TEST REPORT. Include diagnostic test observations and recommendations in report. The final test report is to include pressure test results, Thermographic Investigation findings and the Fog Test Report (if performed).

1.9 CLIMATE CONDITIONS SUITABLE FOR A PRESSURE TEST

A. As the test date approaches, monitor the weather forecast for the test site. Avoid testing on days forecast to experience high winds, rain, or snow. Monitor weather forecasts prior to shipping pressure test equipment to the site. Based on current and forecast weather conditions, the owner's representative is to grant final approval for testing to occur.

1. Rain

a. For safety reasons, avoid testing during rain or if rain is anticipated during testing. If pneumatic hoses are installed and exposed to rain inspect the hose to ensure rainwater has not migrated into the hose ends. Orient all exposed hose ends to keep them out of water puddles. Success in temporarily sealing outdoor ventilation components such as louvers and exhaust fans may also be compromised by rain. Don't seal roof-mounted ventilation components during times of potential lightning.

2. Wind

a. Because wind can skew pressure test results, test only on days and at times when winds are anticipated to be the calmest. Avoid pressure testing during gusty or high wind conditions.

Avoid installing test fans on the windward side of the building if wind gusts during the test are anticipated to be greater than 10 miles per hour.

PART 2 - PRODUCTS

2.1 PRESSURE TEST EQUIPMENT

A. Depending on site conditions and size of the envelope, the test may be conducted using blower door equipment. The testing agency is to supply sufficient quantity of blower equipment that will produce a minimum of 75 Pa differential pressure between the envelope and outdoors using the test methods described herein. Supplying additional blower test equipment to provide additional airflow capacity or to act as a backup is highly recommended.

1. Blower Door Fans

a. Each air flow measuring system including blower door fans are to be calibrated within the last 5 years. Calibrated blower door fans must measure accurately to within plus or minus 5 percent of the flow reading. Blower door equipment are to be specifically designed to pressurize building envelopes. Each set of blower door equipment is to include fan(s), digital gage(s), door frame, door fabric or hard panels.

2. Digital Gauges as Test Instruments

a. Use only digital gauges as measuring instruments in the pressure test; analog gauges are not acceptable. The gauges must be accurate to within 1.0 percent of the pressure reading or 0.15 Pa, whichever is greater. Each gauge is to have been calibrated within two years of the test. The calibration is to be checked against a National Institute of Standards and Technology (NIST, formerly National Bureau of Standards) traceable standard.

3. THERMAL IMAGING CAMERA REQUIREMENTS

a. The thermal imaging camera used in the thermography test must have a thermal sensitivity (Noise Equivalent Temperature Difference.) of +/- 0.18 degrees F at 86 degrees F or less. Ensure the camera's operating spectral range falls between 2 and 15 micrometers. Ensure the camera's IR image viewing screen resolution measures at least 320x240 pixels. Ensure the camera has a means of recording thermal images seen on the camera viewing screen. The camera is to display output as individual still frame images that also can be downloaded and inserted into an electronic Thermographic Investigation Report. All thermographic equipment must comply with the requirements of ISO 6781-2. Submit camera make and model, and catalog information that defines the camera thermal sensitivity for approval.

PART 3 - EXECUTION

3.1 PRESSURE TEST AGENCY

A. The agency is to be regularly engaged in pressure testing of commercial / industrial building envelopes. If using blower door, the lead test technician must have at least two years of experience in using such equipment in building envelope pressurization tests. Formal training using pressure test equipment is highly recommended. Technicians using the building's air handling system for pressure testing are to have tested at least five commercial/industrial buildings within the past three years with each building having over 25,000 square feet of floor area. Submit the name, address, and floor areas of each of these five buildings for approval.

B. Field Work

1. The lead pressure test technician and thermographer are to be present at the project site while testing is performed and is to be responsible for conducting, supervising, and managing of their respective test work. Management includes health and safety of test agency employees.

C. Reporting Work

1. The lead pressure test technician and thermographer are to prepare, sign, and date the test agenda, equipment list, and submit a certified Air Leakage Test Report. The contractor is to prepare a final report that identifies improvements that were made to the envelope to reduce air leaks, mitigate thermal bridging, eliminate moisture migration, repair insulation voids discovered during diagnostic tests. Jointly submit all reports.

3.2 ENVELOPE SURFACE AREA CALCULATION

A. The design architect (AoR) is responsible for defining the air barrier boundary (all 6 sides), showing the boundaries on the drawings, calculating the air barrier envelope surface area, and distributing the calculation result to testing agency.

B. After construction of the air barrier envelope is complete, the testing agency shall field measure/verify the envelope to ensure the physical measurements match the design air barrier envelope surface area calculations. If the calculation result is not within 10 percent of the defined air barrier boundary calculation result as indicated, submit the envelope surface area calculation and results for review.

3.3 PREPARING THE BUILDING ENVELOPE FOR THE PRESSURE TEST

A. Testing During Construction

1. The pressure test cannot be conducted until all components of the air barrier system have been installed. After all sealing as described herein has been completed, inspect the envelope to ensure it has been adequately prepared. During the pressure test, stop all ongoing construction within and neighboring the envelope which may impact the test or the air barrier integrity. The pressure test may be conducted before finishes that are not part of the air barrier envelope have been installed. For example, if suspended ceiling tile, interior gypsum board or cladding systems are not part of the air barrier the test can be conducted before they are installed.

B. Sealing the Air Barrier Envelope

1. The building contractor shall seal all penetrations through the air barrier. Unavoidable penetrations due to electrical boxes or conduit, plumbing, and other assemblies that are not air tight are to be made so by sealing the assembly and the interface between the assembly and the air barrier or by extending the air barrier over the assembly. Support the air barrier so as to withstand the maximum positive and negative air pressure to be placed on the building without displacement or damage and transfer the load to the structure.

2. The building contractor shall durably construct the air barrier to last the anticipated service life of the assembly and to withstand the maximum positive and negative pressures placed on it during pressure testing.

C. Sealing Plumbing

1. Contractor shall prime all plumbing traps located within the envelope full of water.

D. Close and Lock Doors

1. Contractor shall close and lock all doors and windows in the envelope perimeter. For doors not equipped with latching hardware, temporarily secure them in the closed position. Secure the doors

in such a way that they remain fully closed even when the maximum anticipated differential air pressure produced during the test acts on them.

E. Hold Excluded Building Areas at the Outdoor Pressure Level

1. Contractor shall keep building areas immediately surrounding but excluded from the test envelope at the outdoor pressure level during the pressure test. Maintain these areas at the outdoor pressure level by propping exterior doors open, opening windows and de-energizing all air moving devices in or serving these areas.

F. Maintain an Even Pressure within the Envelope

1. Contractor shall ensure the pressure differences within the envelope are minimized by opening all internal air pathways including propping open all interior doors. If, the envelope includes finished suspended ceiling spaces, temporarily remove at least 4 sq ft of every 500 sq ft of ceiling area of tiles located along exterior perimeter or a minimum of 1 tile from each isolated suspended ceiling space, whichever comprises the greatest surface area. Temporarily remove additional ceiling tiles during testing to allow for inspection and diagnostic testing of the ceiling/wall interface.

G. Maintain Access to Mechanical and Electrical Rooms

1. Maintain access to mechanical rooms and electrical rooms associated with the envelope to allow for de-energizing ventilation equipment and resetting circuit breakers tripped by blower door equipment, if used.

H. Minimize Potential for Blowing Dust and Debris

1. Because high velocity air will be blown into and out of the envelope during the test, debris, including dust and litter, may become airborne. Airborne debris may become trapped or entangled in test equipment, thereby skewing test results. Contractor shall ensure areas within and surrounding the envelope are free of dust, litter and construction materials that are easily airborne. If pressurizing existing, occupied areas, provide adequate notice to building occupants of blowing dust and debris, and general disruption of normal activities during the test.

I. De-energize Air Moving Devices

1. Contractor shall coordinate with testing agency to de-energize all air moving devices serving the envelope to keep air within the envelope as still as reasonably achievable. De-energize all fans that deliver air to, exhaust air from the building envelope. Also, de-energize all fans serving areas adjacent to but excluded from the envelope.

J. Installing Blower Door Equipment in a Door Opening

1. Where blower door fans are used, before installing blower door equipment, select a door opening that does not restrict air flow into and out of the envelope and has at least 5 feet clear distance in front of and behind the door opening. Disconnect the door actuator and secure the door open to prevent it from being drawn into the fan by fan pressure. Avoid installing blower door equipment on the windward side of the building.

3.4 BUILDING ENVELOPE AIR TIGHTNESS REQUIREMENT

A. The purpose of the pressure (air leakage) test is to determine final compliance with the airtightness requirement by demonstrating the performance of the continuous air barrier. An effective air barrier envelope minimizes infiltration and exfiltration through unintended air paths (leaks).

B. Architectural Test

1. The test envelope is the architectural air barrier boundary as defined on the contract drawings. This boundary includes connecting walls, roof and floor which comprise a complete, whole, and continuous three-dimensional envelope. Perform both a positive pressure test and a negative pressure test on this envelope, unless otherwise directed.

2. Test Goal

   a. Contractor shall provide exterior enclosure meeting or exceeding the following performance requirements:

      1) Full Building Air Leakage: Air Leakage through full building enclosure shall be targeted to achieve **0.25 cfm/sq. ft.** of envelope surface area when tested in accordance with ASTM E 1827 at a static-air-pressure difference of 0.30 in. w.g.

      2) The envelope passes the test if the leakage rate is equal to or lower than the tested leakage rate goal.

Leakage Rate Performance Tier	Envelope Air Leakage Rate (CFM75/sq ft)
Project Specific Target High-Performance Rate	**~0.30**
Other Reference Leakage Rates:	
Ultra-Tight Air Barriers	0.08 to 0.11
National High-Performance Air barriers (IgCC, US GSA, USACE)	0.25
Typical Modern Construction (2021 IECC)	0.40
Leaky Construction	>0.40
Note: CFM75/sq ft is cfm/sq. ft. of surface area when tested in accordance with ASTM E1827 at a static-air-pressure difference of 0.30 in. w.c. (75 Pa).	

3. Preparing the Envelope for the Pressure Test - Seal All Openings through the Air Barrier

   a. Contractor shall temporarily close all perimeter windows, roof hatches and doors in the envelope perimeter except for those doors that are to remain open to accommodate blower door fan test equipment installation. Seal, or isolate all other intentional openings, pathways and fenestrations through the architectural envelope prior to pressure testing. Follow the Recommended Test Envelope Conditions identified in ASTM E1827, Table 1, for the Closed Envelope condition. These openings may include boiler flues, fuel-burning water heater flues, fuel-burning kitchen equipment, clothes dryer vents, fireplaces, wall or ceiling grilles, diffusers etc. Before sealing flues, close their associated fuel valves and verify the associated pilot lights are extinguished. Prime all plumbing traps located within the envelope full of water. In lieu of applying tape and/or plastic, typical temporary sealing materials include tape and sheet plastic or a self-adhesive grille wrap. Use and apply tape and plastic in a manner that does not deface or remove paint or mar the finish of permanent surfaces. Be especially aware of residue that remains from tape applied to stainless steel surfaces such as

kitchen hoods or rollup doors. For painted surfaces, use tape types that do not remove finish paint when the tape is removed. If paint is removed from the finished surface, repaint to match existing surfaces. Secure dampers closed either manually or by using the building's HVAC system controls.

b. Use the table below for further guidance in building preparation.

Building Component	Envelope Condition
Air handling units, duct fans	As found (open) or temporarily sealed as necessary
Clothes dryer	Off
Clothes dryer vents	Temporarily sealed
Dampers - intake, exhaust	Physically closed or closed using control power or temporarily sealed
Diffusers, registers, grilles within the envelope	Temporarily sealed
Doors, personnel type, at the envelope perimeter	Secured closed
Doors, personnel type, within the envelope	Secured (propped) open – Interior doors only
Doors, roll-up type, at the envelope perimeter	Closed (no additional sealing)
Exhaust hoods	Closed* and temporarily sealed
Fireplace hearth	Temporarily sealed *
Kitchen hoods	Temporarily sealed *
Pilot light and associated fuel valve	Extinguished and closed, respectively
Vented combustion appliance	Temporarily sealed *
Vented combustion appliance exhaust flue	Off
Windows	Secured closed
* If the building component has an associated manual or automatic damper, consider securing the damper closed in lieu of temporarily sealing.	

3.5 CONDUCTING THE PRESSURE TEST

A. Notify the owner group at least 10 working days before conducting the pressure tests to provide them the opportunity to witness the tests and to monitor weather forecasts for conditions favorable for testing. Do not pressure test until verifying that the continuous air barrier is in place and installed without failures in accordance with installation instructions. During the pressure test the contractor shall assist the testing agency with periodically inspecting temporarily sealed items to ensure they are still sealed. Seals on temporarily sealed items tend to release more readily at higher pressures. Test data obtained after temporarily sealed items become unsealed cannot be used as test results may be skewed.

B. Extend Pneumatic Tubes and Establish a Reference Differential Pressure

1. Confirm the various zones within the envelope have a relatively uniform interior pressure distribution by establishing a representative differential pressure between the envelope and the outdoors with blower door fans operating.

C. Bias Pressure Readings

1. With the fan pressurization equipment de-energized and the envelope sealed, obtain the differential pressure between the outdoors and the envelope. Record 12 bias pressure readings before the pressure test and 12 bias pressure readings after the pressure test. Each reading is the average of ten or more 1-second measurements. Include positive and negative signs for each reading. To help dampen bias pressures that significantly contribute to test pressure, reduce temperature differences between indoor and outdoor air. Temperature differences can be reduced by operating test fan equipment for a few minutes to replace most of the indoor air with outdoor air.

D. Testing in Both Positive and Negative Directions

1. The preferred method for testing a building envelope is to test in both the pressurized and depressurized directions. Testing in one direction is only allowed if opposite direction testing cannot logistically be performed due to test equipment limitations or restrictions. The depressurized test shall be performed prior to the pressurized test direction so as to not introduce excessive outside prior to starting the second test.

2. After obtaining the pre-test bias differential pressure readings, conduct the pressure test. Record the envelope pressures (in units of Pascals) from one interior pneumatic hose (monitoring port) and the outdoor pneumatic hose(s), averaged or manifolded, with corresponding flows (in units of cfm) for each fan. Record the flow rates at least 10 to 12 positive and 10 to 12 negative building pressure readings. The lowest allowable test pressure is at least the absolute value of the greatest bias pressure test point x (10/3). The maximum allowable test pressure is at least 25 Pa greater than the minimum test pressure. Keep at least 25 Pa difference between the lowest and highest test pressure readings. Include the 75 Pa pressure value between the lowest and highest readings. The 10 to 12 readings in each direction are to be roughly evenly spaced along the range of pressures and flows. After testing is complete de-energize the equipment used to provide pressurization and obtain an additional 10 to 12 post-test bias pressure readings. None of the bias pressure readings are allowed to exceed 30 percent of the minimum test pressure. If these limits are exceeded the test fails and must be repeated.

E. Pressure Testing - Special Cases

1. Pressure Testing a Multiple Isolated Zoned Building

a. The owner representative and/or Architect shall coordinate with the testing agency to select how each zone will be selected to test, should multiple tests be required. Typically, zones are selected based on being separated by 2-hour fire walls or areas that can be easily sealed with temporary barriers and have minimal or no penetrations. If all tested zones pass, no further testing is needed. If any zone in this group fails the test re-seal and re-test the zone until it passes. Continue this process until all the tested zones pass.

b. When testing a zone, the doors to all adjacent zones that share a common surface with the tested zone are to have their doors opened to the outdoors, to depressurize.

2. Pressure Testing a Building Addition

a. If the existing building is occupied, coordinate the pressure test with building representatives. In preparation of the test, de-energize the air handling system serving that portion of the existing building that shares surfaces with the new building addition. Pressure testing a new building addition may also require pressurizing that part of the existing building that shares

surfaces in common with the new building addition. If an air barrier is applied to the common surfaces separating the existing building from the new addition, prior to the test prop open a sufficient quantity of doors and/or windows to keep the existing building at the same pressure as the outdoors. If an air barrier is not applied to the common surfaces separating the existing building from the new addition, pressurize that part of the existing building that shares surfaces in common with the building addition to the same level as the as the addition using separate test pressurization equipment.

F. Failed Pressure Test

1. If the pressure test fails to meet the established criteria, use diagnostic test methods described in paragraph LOCATING LEAKS BY DIAGNOSTIC TESTING to discover the leak locations. Provide additional permanent sealing measures to reduce or eliminate leak sources discovered during diagnostic testing. It is recommended to retest (perform another pressure test) after sealing has been completed. Repeat this sequence of documenting test results in the test report, performing diagnostic tests, documenting recommendations for additional sealing measures in the test report, sealing leak locations per recommendations, and re-testing as necessary until the building envelope passes the pressure test and is in compliance with the performance requirements.

G. Air Leakage Test Report

1. Report volumetric flow rates and corresponding differential pressures in cubic feet per minute (cfm) and Pascals (Pa), respectively, in the Air Leakage Test final report. Populate the report with information obtained during the test. Use equations found in ASTM E779 as a basis for calculating the envelope leakage rate. Should any air tightness (pressure) test fail, the pressure test report is to include data and results from all previous failed tests along with the final successful test data and results. Indicate if the resulting leakage rate did or did not meet the goal leakage requirement.

   Identify and document deficiencies in the building construction upon failure of a test to meet the specified maximum leakage rate.

2. Include the Test Agency Qualifications, Air Leakage Test Results in the written report. Document every test set-up condition with diagrams and photos to ensure the tests can be made repeatable. Document all pneumatic hose termination locations. Record in detail how the building envelope was prepared for the tests. Also describe in detail which building items were temporarily sealed. Include photos of test equipment and sealing measures in the report. Distribute an electronic (pdf) version of all test reports to the owner representative, Architect and building general contractor. If the building envelope fails to meet the leakage rate goal, provide recommendations to further seal the envelope and document these recommendations in the test report.

3.6 LOCATING LEAKS BY DIAGNOSTIC TESTING

A. Use diagnostic test methods described herein to discover obvious leaks through the envelope. Perform diagnostic tests on the building envelope regardless of the envelope meeting or failing to meet the designated leakage rate goal. Use diagnostic test methods in accordance with ASTM E1186 and in conjunction with pressurization equipment as necessary. Use the thermography diagnostic test to establish a baseline for envelope leakage. Apply additional diagnostic tests (find, feel, fog or other tests) as necessary to further define leak locations and pathways discovered using thermography or to find additional leaks not readily detected by thermography.

B. Using a variety of diagnostic tests may help locate leaks that would otherwise go undetected if only a single diagnostic test were used. Pay special attention to locating leaks at interfaces where there is a change in materials or a change in direction of like materials. These interfaces, at a minimum, include roof/wall, wall/wall, floor/wall, wall/window, wall/door, wall/louver, roof mounted equipment/roof curb interfaces and all utility penetrations (ducts, pipes, conduit, etc.) through the envelope's architecture.

C. Should leaks be discovered during diagnostic tests, thoroughly document their exact locations on a floor plan so that sealing can be later applied, if required or as directed. If the envelope passes the leakage test, use the diagnostic test procedure described above to identify obvious leakage locations.

D. Contractor shall seal the leaks at the discretion of the AoR and/or testing agency based on the magnitude, location, potential for liquid moisture penetration or retention, potential for condensation, presence of daylight through an architectural surface or if the leakage location could potentially cause rapid deterioration or mold growth of, or in the building envelope materials and assemblies. Contractor shall apply sealing measures after diagnostic testing is complete and all pressurization blowers are off. To verify that the applied sealing measures that are effective, a re-test for leaks using the same diagnostic methods that discovered the leak, may be utilized. If so, reseal and retest until the envelope meets the leakage rate goal and all obvious leaks through the envelope are sealed.

E. Find Test

1. Use visual observation to locate daylight and/or artificial light streaming from the opposite side of the envelope. Observe all interfaces identified above.

F. Feel Test

1. Utilizing the testing agency blower door equipment to negatively pressurize the building envelope, to at least 25 Pa but no greater than 85 Pa, with respect to the outdoors, while inside the envelope, hand feel roof/wall, wall/wall, and floor/wall interfaces and utility penetrations (ducts, pipes, conduit, etc.) for leaks and note the leak locations on a floor plan.

2. The "Feel" test may also be used to check for leaks between the ductwork and ductwork damper. To do this, positively pressurize the envelope and check for air movement from the envelope exterior.

G. Infrared Thermography Test

1. Coordinate thermography examination with the pressure test agency and the test agency's pressurization equipment. The pressure test agency is to allow adequate time for the thermographer to perform a complete thermographic examination, as described hereinafter, of the envelope interior and exterior.

2. Thermography Test Methods

a. It is optimal to avoid conducting exterior examinations during mid to late afternoon when the influence of solar radiation is most probable. Conduct thermal imaging tests only when wind speeds are less than 8 mph at the time of analysis and at the end of analysis. Document any variations in wind during the test. Document all variations of test conditions in the Thermographic Investigation Report. Test only when exterior surfaces are dry. Monitor and document ongoing test parameters, such as the temperatures inside and outside the air barrier envelope, wind speed, and differential pressure.

b. Thermography Testing of the Air Barrier

1) Test the building envelope in accordance with ISO 6781, and ASTM E1186. Perform a complete thermographic inspection consisting of the full inspection of the interior and exterior of the complete air barrier envelope. Document envelope areas that are inaccessible for testing. Use infrared thermography technology in concert with standard pressurization methods (blower doors fans) to locate leaks through the air barrier. Because thermography works best with at least an 18-degree F temperature difference between the envelope interior and the exterior, adjust the HVAC system, if possible, to create or enhance this temperature difference. Maintain this temperature difference for at least 3 hours prior to the test. Use pressurization methods to establish a minimum of +20 Pa pressure difference with respect to the outdoors while using an infrared camera to view the envelope from outdoors. When viewing with the camera from inside the envelope, keep the envelope at a pressure differential of -20 Pa with respect to the outdoors using pressure testing equipment.

3. Thermography Test Results

a. Document the location of all leaks, anomalies, and unusual thermal features on a floor plan and/or elevation view and catalog them with a visible light picture for locating the defect for correction. The thermographer is to coordinate with the Architect of Record for recommended corrective actions to eliminate the leaks, anomalies and unusual thermal features.

b. Where leaks are found, the contractor shall perform corrective sealing as necessary to achieve the whole envelope air leakage rate specified. After sealing, it is recommended to again use thermography in concert with standard pressurization methods to verify that the air leakage has been reduced. After these leaks have been permanently sealed, note all actions taken on the drawings or in the Thermographic Investigation Report. Submit the drawings for approval as part of the Thermographic Investigation Report. Also include thermographic photos that show where leaks were discovered. Include thermograms using an imaging palette that clearly shows the observed thermal patterns indicating air leakage. It is recommended that the Owner Representative and/or Architect is to witness all testing.

H. Fog Test

1. Many times, it is recommended to perform a Fog Test immediately after an air/vapor barrier material is applied to a building envelope to verify the wall/roof assembly integrity. The following are criteria the testing agency and contractor team should adhere to facilitate this testing:

2. Before using a theatrical fog generator, disable all building smoke detectors as they may alarm when fog is issued. Coordinate fog tests and the disabling of all smoke detectors with the General Contractor representative and the local fire department as necessary. Use pressure test equipment to positively pressurize the building envelope to at least 25 Pa but not greater than 85 Pa over the outdoors. Using a theatrical fog generator within the envelope, direct fog at suspected leakage points such as at building interfaces. Test the following interfaces: roof/wall, wall/wall, floor/wall, wall/window, roof/mounted mechanical equipment. From the vantage point immediately outside the envelope and opposite that of the interface being tested, observe the effect as the fog is issued.

3. Detection may also be further enhanced by using a scented fog liquid or a fog liquid that produces a colored fog. Look for fog and smell for associated odor percolating through the interface. Also, the use of smoke puffers and smoke sticks may be necessary to locate leaks at these and other interface locations.

4. After fog testing has ended, reactivate the building smoke detectors, and notify the General Contractor and local fire department that the test has ended. Retesting may be required to facilitate a properly sealed air/vapor barrier. Contractor shall seal additional leaks that are found.

I. Diagnostic Test Report

1. Once the diagnostic tests have been completed and the leakage locations identified and sealed, document these procedures, locations, and recommendations in the diagnostic test section of the Air Barrier Pressure Test Report. Submit plan and/or profile drawings that thoroughly identify leak locations. Describe in detail all leak locations so that the seal-up crew knows where to apply sealing measures. After sealing measures have been applied, describe the methods used along with applicable photos of the final sealed condition.

3.7 AFTER COMPLETION OF THE PRESSURE AND/OR DIAGNOSTIC TESTS

A. After all pressure and/or diagnostic testing has been completed unseal all temporarily sealed items. Unless otherwise directed by the owner group, return all dampers, doors, and windows to their pre-test condition. Remove tape and plastic from all temporarily sealed openings, being careful not to deface painted surfaces. If paint is removed from finished surfaces, contractor shall repaint to match existing surfaces. Unless

otherwise directed by the Owner Group representative, contractor shall return fuel (gas) valves to their pre-test position and relight pilot lights. Controls Contractor shall return all fans and air handling units to pre-test conditions.

3.8 REPAIR AND PROTECTION

A. Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for testing, inspection, and similar services. Upon completion of inspection, testing, or sample taking and similar services, repair damaged construction and restore substrates and finishes, protect construction exposed by or for quality control service activities, and protect repaired construction.

END OF SECTION 070523

SECTION 07 14 00
FLUID-APPLIED WATERPROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Water-based asphalt emulsion waterproofing.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete substrate.

B. Section 07 21 00 - Thermal Insulation: Insulation used for protective cover.

C. Section 07 62 00 - Sheet Metal Flashing and Trim: Metal parapet covers, copings, and counterflashings.

1.3 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 D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).

C. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers; 2022.

D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).

E. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

1.4 SUBMITTALS

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

B. Product Data: Provide data for membrane, surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants.

C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.

D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and acceptable installation temperatures.

E. Manufacturer's qualification statement.

F. Installer's qualification statement.

G. Warranty Documentation:

1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
2. Submit installer's documentation that installation complies with warranty conditions for the field-applied waterproofing.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.

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

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until cured.

1.7 WARRANTY

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

B. Installer Warranty: Provide 5-year warranty for waterproofing failing to resist penetration of water commencing on Date of Substantial Completion. Complete forms in Owner's name and register with installer.

C. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Water-Based Asphalt Emulsion Waterproofing:
1. Carlisle Coatings & Waterproofing, Inc: www.carlisleccw.com/#sle.
2. Mar-flex Waterproofing & Building Products: www.mar-flex.com/#sle.
3. Rust-Oleum Corporation: www.rustoleum.com/#sle.
4. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.
5. W.R. Meadows, Inc: www.wrmeadows.com/#sle.
6. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FLUID-APPLIED WATERPROOFING APPLICATIONS

A. Water-Based Asphalt Emulsion Waterproofing:
1. Cover with protection board.

2.3 FLUID-APPLIED WATERPROOFING MATERIALS

A. Water-Based Asphalt Emulsion Waterproofing:
1. Cured Thickness: 60 mil, 0.060 inch, minimum.
2. Suitable for installation over concrete substrates.
3. Elongation: 1,000 percent, minimum, measured in accordance with ASTM D412.

4. VOC Content: Less than 20 g/L when tested in accordance with 40 CFR 59, Subpart D (EPA Method 24).
5. Water Vapor Permeability: 0.02 perm, maximum, measured in accordance with ASTM E96/E96M.
6. Adhesion: 150 psi, minimum, measured in accordance with ASTM D4541.

B. Flexible Flashings: Type recommended by membrane manufacturer.

C. Joint Cover Sheet: 1 inch minimum thickness, elastic sheet material designated for and compatible with membrane.

2.4 ACCESSORIES

A. Sealant for Joints and Cracks in Substrate: Type compatible with waterproofing material and as recommended by waterproofing manufacturer.

B. Protection Board: Rigid insulation; see Section 07 21 00.

C. Cant Strips: Premolded composition material.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.

C. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.

D. Verify that items penetrating surfaces to receive waterproofing are securely installed.

E. Where existing conditions are responsibility of another installer, notify Architect of unsatisfactory conditions.

F. Do not proceed with this work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect adjacent surfaces from damage not designated to receive waterproofing.

B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions; vacuum substrate clean.

C. Do not apply waterproofing to surfaces unacceptable to waterproofing manufacturer.

D. Fill non-moving joints and cracks with a filler compatible with waterproofing materials.

E. Seal moving cracks with sealant and non-rigid filler, using procedures recommended by sealant and waterproofing manufacturers.

F. Prepare building expansion joints at locations as indicated on drawings.

G. Install cant strips at inside corners.

3.3 INSTALLATION

A. Install waterproofing to specified minimum thickness in accordance with manufacturers instructions and NRCA (WM) applicable requirements.

B. Apply primer or surface conditioner at a rate recommended by manufacturer, and protect conditioner from rain or frost until dry.

C. At joints and cracks less than 1/2 inch in width including joints between horizontal and vertical surfaces, apply 12 inch wide strip of joint cover sheet.

D. At joints from 1/2 inch to 1 inch in width, loop joint cover sheet down into joint between 1-1/4 inch to 1-3/4 inch, and extend sheet at least 6 inches on either side of expansion joint.

E. Center joint cover sheet over joints, roll sheet into 1/8 inch thick coating of waterproofing material and apply second coat over sheet extending at least 6 inches beyond sheet edges.

F. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 6 inches above horizontal surface for first ply and ____ inches at subsequent plies laid in shingle fashion.

G. Apply extra thickness of waterproofing material at corners, intersections, and angles.

H. Seal membrane and flashings to adjoining surfaces.

3.4 INSTALLATION - PROTECTION BOARD

A. Immediately after cooling, dust membrane with tack-reducing surfacing at rate of approximately 10 lb/100 sq ft.

B. Place protection board directly against cooled membrane; butt joints, and scribe and cut boards around projections, penetrations, and interruptions.

3.5 FIELD QUALITY CONTROL

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

B. Upon completion of horizontal membrane installation, dam installation area in preparation for flood testing.
   1. Flood to minimum depth of 1 inch with clean water, and after 48 hours inspect for leaks.
   2. If leaking is found, remove water, repair leaking areas with new waterproofing materials as directed by Architect; repeat flood test, and repair damage to building.
   3. When area is proven watertight, drain water and remove dam.

3.6 PROTECTION

A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION 07 14 00

SECTION 07 21 00
THERMAL INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Board insulation at cavity wall construction and perimeter foundation wall.

B. Batt insulation in exterior wall construction.

C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Installation requirements for board insulation over steep slope roof sheathing or roof structure.

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

1.3 DEFINITIONS

A. Mineral Fiber Material Composition: Insulation referred to as mineral fiber block, board, and blanket insulation is composed of fibers from mineral based substances such as rock, slag, or glass and processed from the molten state into fibrous form.
   1. Based on type of insulation substance, the material will be referred to as a mineral fiber when having a rock or slag base, and glass fiber with a glass or silica sand base, also considered a mineral.
   2. Insulation blankets are flexible units consisting of felted, bonded, or unbonded fibers formed into rolls or flat cut pieces referred to as batts; rolls are simply longer versions of batts.
   3. For additional information about mineral fiber and the various classification types, refer to the following reference standards; ASTM C553, ASTM C612, ASTM C665, and ASTM C726.

1.4 REFERENCE STANDARDS

A. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).

B. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2023.

C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).

D. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.

E. ASTM C726 - Standard Specification for Mineral Wool Roof Insulation Board; 2017.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

G. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 °C; 2022.

1.5 SUBMITTALS

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

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

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

D. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

1.6 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 APPLICATIONS

A. Insulation at Perimeter of Foundation: Extruded polystyrene (XPS) board.

B. Insulation in Metal Framed Walls: Batt insulation with no vapor retarder.

2.2 FOAM BOARD INSULATION MATERIALS

A. Extruded Polystyrene (XPS) Board Insulation: Comply with ASTM C578 with either natural skin or cut cell surfaces.
   1. Type and Compressive Resistance: Type VI, 40 psi (276 kPa), minimum.
   2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
   3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
   4. Type and Thermal Resistance, R-value: Type IV, 5.0 (0.88), minimum, per 1 inch thickness at 75 degrees F mean temperature.
   5. Board Edges: Square.
   6. Type and Water Absorption: Type XII, 0.3 percent by volume, maximum, by total immersion.
   7. Products:
      a. DuPont de Nemours, Inc; Styrofoam Brand Square Edge: building.dupont.com/#sle.
      b. Kingspan Insulation LLC; GreenGuard GG25-LG XPS Insulation Board: www.kingspan.com/#sle.
      c. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 MINERAL FIBER BLANKET INSULATION MATERIALS

A. Flexible Glass Fiber Blanket Thermal Insulation: Preformed insulation, complying with ASTM C665; friction fit.
   1. Flame Spread Index: 75 or less, when tested in accordance with ASTM E84.
   2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.

3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
4. Formaldehyde Content: Zero.
5. Thermal Resistance: R-value of 21.
6. Thickness: 6 inch or as indicated..
7. Products:
   a. CertainTeed Corporation: www.certainteed.com/#sle.
   b. Johns Manville: www.jm.com/#sle.
   c. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
   d. Substitutions: See Section 01 60 00 - Product Requirements.

2.4 ACCESSORIES

A. Sheet Vapor Retarder: See Section 07 26 00.

B. Sill Plate Sealer: Closed-cell foam tape with rubberized adhesive membrane; bridges gap between foundation structure and sill plate or skirt board.
   1. Width: 3-1/2 inches.
   2. Ultraviolet (UV) and Weathering Resistance: Approved in writing by manufacturer for up to 30 days of weather exposure.

C. Air and Moisture Sealing Insulation Fasteners: Preassembled fastener units consisting of sealing washer, screw, and gasketing tube.

D. Adhesive: Type recommended by insulation manufacturer for application.

PART 3 EXECUTION

3.1 EXAMINATION

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

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

3.2 BOARD INSTALLATION AT FOUNDATION PERIMETER

A. Adhere a 6 inches wide strip of polyethylene sheet over construction, control, and expansion joints with double beads of adhesive each side of joint.
   1. Tape seal joints.
   2. Extend sheet full height of joint.

B. Apply adhesive to back of boards:
   1. Three continuous beads per board length.
   2. Full bed 1/8 inch thick.

C. Install boards horizontally on foundation perimeter.
   1. Place boards to maximize adhesive contact.
   2. Butt edges and ends tightly to adjacent boards and to protrusions.

D. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.3 BATT INSTALLATION

A. Install insulation and vapor retarder in accordance with manufacturer's instructions.

B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.

C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

E. At wood framing, place vapor retarder on warm side of insulation by stapling at 6 inches on center. Lap and seal sheet retarder joints over face of member.

F. Tape seal tears or cuts in vapor retarder.

G. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane; tape seal in place.

3.4 FIELD QUALITY CONTROL

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

3.5 PROTECTION

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

END OF SECTION 07 21 00

SECTION 07 25 00
WEATHER BARRIERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Water-resistive barriers.

1.2 RELATED REQUIREMENTS

A. Section 07 24 00 - Exterior Insulation and Finish Systems: Water-resistive barrier under exterior insulation.

B. Section 07 62 00 - Sheet Metal Flashing and Trim: Metal flashings installed in conjunction with weather barriers.

1.3 DEFINITIONS

A. Weather Barriers: Assemblies that form either water-resistive barriers, air barriers, or vapor retarders.

B. Water-Resistive Barrier: A material behind an exterior wall covering that is intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the exterior wall assembly.

1.4 REFERENCE STANDARDS

A. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2021.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

C. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).

1.5 SUBMITTALS

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

B. Product Data: Provide data on material characteristics.

C. Shop Drawings: Provide drawings of special joint conditions.

D. Manufacturer's Installation Instructions: Indicate preparation, installation methods, and storage and handling criteria.

1.6 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by materials manufacturers before, during, and after installation.

PART 2 PRODUCTS

2.1 WATER-RESISTIVE BARRIER MATERIALS

A. Water-Resistive and Air Barrier, Multilayers: Nonwoven fabric laminated to polyethylene film.
   1. Water Vapor Permeance: 15 perms, minimum, when tested in accordance with ASTM E96/E96M using Procedure A - Desiccant Method, at 73.4 degrees F.
   2. Ultraviolet (UV) and Weathering Resistance: Approved by manufacturer for up to 3 months of weather exposure.
   3. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A when tested in accordance with ASTM E84.
   4. Seam and Perimeter Tape: As recommended by sheet manufacturer.
   5. Products:
      a. Alpha Pro Tech, Inc: www.alphaprotech.com/#sle.
      b. DuPont de Nemours, Inc: www.dupont.com.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 ACCESSORIES

A. Sealants, Tapes, and Accessories Used for Sealing Water-Resistive Barrier and Adjacent Substrates: As indicated or complying with water-resistive barrier manufacturer's installation instructions.

B. Flexible Flashing: Self-adhesive sheet flashing complying with ASTM D1970/D1970M, except slip resistance requirement is waived if not installed on a roof.
   1. Width: 4 inches.
   2. Ultraviolet (UV) and Weathering Resistance: Approved by manufacturer for up to 30 days of weather exposure.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces and conditions comply with requirements of this section.

3.2 PREPARATION

A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.

B. Clean and prime substrate surfaces to receive adhesives and sealants in accordance with manufacturer's installation instructions.

3.3 INSTALLATION

A. Install materials in accordance with manufacturer's installation instructions.

B. Water-Resistive Barriers: Install continuous water-resistive barrier over surfaces indicated, with sheets lapped to shed water but with seams not sealed.

C. Apply sealants and adhesives within recommended temperature range in accordance with manufacturer's installation instructions.

D. Mechanically Fastened Exterior Sheets:
   1. Install sheets shingle-fashion to shed water, with seams aligned horizontal.
   2. Overlap seams as recommended by manufacturer, 6 inches, minimum.
   3. Overlap at outside and inside corners as recommended by manufacturer, 12 inches, minimum.
   4. Install water-resistive barrier over jamb flashings.
   5. Install head flashings under water-resistive barrier.
   6. At framed openings with frames having nailing flanges, extend sheet into opening and over flanges; at head of opening, seal sheet over flange and flashing.

E. Openings and Penetrations in Exterior Water-Resistive Barriers:
   1. Install flashing over sills, covering entire sill framing member, and extend at least 5 inches onto water-resistive barrier and at least 6 inches up jambs; mechanically fasten stretched edges.
   2. At openings filled with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with sealing tape at least 4 inches wide; do not seal sill flange.
   3. At openings filled with nonflanged frames, seal water-resistive barrier to each side of framing at opening using flashing at least 9 inches wide, and covering entire depth of framing.
   4. At head of openings, install flashing under water-resistive barrier extending at least 2 inches beyond face of jambs; seal water-resistive barrier to flashing.
   5. At interior face of openings, seal gaps between window and door frames and rough framing using appropriate joint sealant over backer rod.
   6. Service and Other Penetrations: Form flashing around penetrating items and seal to surface of water-resistive barrier.

3.4 FIELD QUALITY CONTROL

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

B. Do not cover installed water-resistive barriers until required inspections have been completed.

C. Obtain approval of installation procedures from water-resistive barrier manufacturer based on a mock-up installed in place, prior to proceeding with remainder of installation.

D. Take digital photographs of each portion of installation prior to covering up weather barriers.

3.5 PROTECTION

A. Do not leave materials exposed to weather longer than recommended by manufacturer.

END OF SECTION 07 25 00

SECTION 07 26 00
VAPOR RETARDERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Vapor retarders.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Vapor retarder under concrete slabs on grade.

B. Section 07 21 00 - Thermal Insulation: Vapor retarder installed in conjunction with batt insulation.

1.3 DEFINITIONS

A. Vapor Retarder: Airtight barrier made of material that is relatively water vapor impermeable, to degree specified, with seams and joints sealed to adjacent surfaces.

B. Vapor Retarder Class: A measure of a material or assembly's ability to limit the amount of moisture that passes through that material or assembly. Vapor retarder class is defined using Procedure A, Desiccant Method at 73 degrees F and 50 percent Relative Humidity (RH), in accordance with ASTM E96/E96M and ICC (IBC)-2018, as follows:
   1. Class I: 0.1 perm or less.
   2. Class II: Greater than 0.1 perm to 1.0 perm.
   3. Class III: Greater than 1.0 perm to 10 perms.
   4. Vapor Permeable: 5 perms or greater.

1.4 REFERENCE STANDARDS

A. ASTM D4397 - Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications; 2016 (Reapproved 2023).

B. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).

C. ICC (IBC)-2018 - International Building Code; 2018.

1.5 SUBMITTALS

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

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

C. Shop Drawings: Provide drawings of special joint conditions.

D. Manufacturer's Installation Instructions: Indicate preparation, installation methods, and storage and handling criteria.

E. Testing agency qualification statement.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

1.7 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by materials manufacturers before, during, and after installation.

PART 2 PRODUCTS

2.1 VAPOR RETARDERS

A. Vapor Retarder Sheet: Polyethylene sheeting complying with ASTM D4397, clear colored.
   1. Thickness: 10 mil, 0.010 inch, nominal.
   2. Water Vapor Permeance: 0.1 perm, maximum, when tested in accordance with ASTM E96/E96M.
   3. Seam and Perimeter Tape: Polyethylene self-adhering type, mesh reinforced, 2 inches wide; compatible with sheet material.

2.2 ACCESSORIES

A. Sealants, Tapes, and Accessories for Sealing Vapor Retarder and Adjacent Substrates: As indicated, complying with vapor retarder manufacturer's installation instructions.

B. Thinners and Cleaners: As recommended by vapor retarder manufacturer.

C. Vapor Retarder Self-Sealing Flat Attachment Washers: Solid plastic flat cap washers with flexible perimeter seal attached with screws to substrate for attachment of vapor retarder to help seal against air and moisture penetration through vapor retarder assembly.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces and conditions comply with requirements of this section.

3.2 PREPARATION

A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.

B. Clean and prime substrate surfaces to receive adhesives and sealants in accordance with manufacturer's installation instructions.

3.3 INSTALLATION

A. Install materials in accordance with manufacturer's installation instructions.

B. Vapor Retarders: Install continuous airtight barrier over surfaces indicated, with sealed seams and sealed joints to adjacent surfaces.

C. Apply sealants and adhesives within recommended temperature range in accordance with manufacturer's installation instructions.

D. Mechanically Fastened Sheets - Vapor Retarder On Interior:
   1. When insulation is installed within assembly, install vapor retarder over insulation.
   2. Anchor to wood framing using large-headed nails or staples at 12 to 18 inches on center along each framing member covered; cover fasteners with seam tape.
   3. Seal seams, laps, perimeter edges, penetrations, tears, and cuts with self-adhesive tape, providing an airtight seal.
   4. Locate laps at framing members; at laps fasten one sheet to framing member then tape overlapping sheet to first sheet in shingle fashion to shed water.
   5. Seal entire perimeter to structure, window and door frames, and other penetrations.
   6. Where conduits, pipes, wires, ducts, outlet boxes, and other items are installed within insulation cavity, pass vapor retarder sheet behind these items and over insulation to maintain airtight seal.

3.4 FIELD QUALITY CONTROL

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

B. Do not cover installed vapor retarders until required inspections have been completed.

C. Obtain approval of installation procedures from vapor retarder manufacturer based on a mock-up installed in place, prior to proceeding with remainder of installation.

D. Take digital photographs of each portion of installation prior to covering up vapor retarders.

3.5 PROTECTION

A. Do not leave materials exposed to weather longer than recommended by manufacturer.

END OF SECTION 07 26 00

SECTION 07 42 13.23
METAL COMPOSITE MATERIAL WALL PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior cladding consisting of formed metal composite material (MCM) sheet, secondary supports, and anchors to structure, attached to solid backup.

B. Matching flashing and trim.

1.2 RELATED REQUIREMENTS

A. Section 05 40 00 - Cold-Formed Metal Framing: Panel support framing.

B. Section 07 25 00 - Weather Barriers: Water-resistive barrier behind wall panel system.

C. Section 07 62 00 - Sheet Metal Flashing and Trim: Metal flashing components integrated with this wall system.

D. Section 07 92 00 - Joint Sealants: Sealing joints between siding and adjacent construction and fixtures.

1.3 REFERENCE STANDARDS

A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.

B. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

E. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

F. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.

G. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2023b.

H. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.

I. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

J. ASTM D1781 - Standard Test Method for Climbing Drum Peel for Adhesives; 1998 (Reapproved 2021).

K. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2023.

L. ASTM D4145 - Standard Test Method for Coating Flexibility of Prepainted Sheet; 2010 (Reapproved 2022).

M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

N. 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.

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).

P. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).

Q. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2023.

1.4 SUBMITTALS

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

B. Product Data - MCM Sheets: Manufacturer's data sheets on each product to be used, including thickness, physical characteristics, and finish, and:
   1. Finish manufacturer's data sheet showing physical and performance characteristics.
   2. Storage and handling requirements and recommendations.
   3. Fabrication instructions and recommendations.

C. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
   1. Physical characteristics of components shown on shop drawings.
   2. Storage and handling requirements and recommendations.
   3. Installation instructions and recommendations.
   4. Specimen warranty for wall system, as specified herein.

D. Shop Drawings: Show layout and elevations, dimensions and thickness of panels, connections, details and location of joints, sealants and gaskets, method of anchorage, support clips, exposed fasteners, number of anchors, supports, reinforcement, trim, flashings, and accessories.
   1. Indicate panel numbering system.
   2. Differentiate between shop and field fabrication.
   3. Indicate substrates and adjacent work with which the wall system must be coordinated.
   4. Include large-scale details of anchorages and connecting elements.
   5. Include large-scale details or schematic, exploded or isometric diagrams to fully explain flashing at a scale of not less than 1-1/2 inches per 12 inches.
   6. Include design engineer's stamp or seal on shop drawings for attachments and anchors.

E. Verification Samples: For each finish product specified, submit at least three samples, minimum size 12 inch square, and representing actual product in color and texture.

F. Design Data: Submit structural calculations stamped by design engineer, for Architect's information and project record.

G. Test Report: Submit report of full-size mock-up tests for air infiltration, water penetration, and wind performance.

H. Test Report: Submit test report verifying compliance with NFPA 285 for previously-tested exterior wall assembly.

I. Manufacturer's Field Reports: Provide within 48 hours of field review. State what was observed and what changes, if any, were requested or required.

J. Designer's qualification statement.

K. Manufacturer's qualification statement.

L. Installer's qualification statement.

M. Testing agency's qualification statement.

N. Maintenance Data: Care of finishes and warranty requirements.

O. Executed Warranty: Submit warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Field Measurements: Verify actual dimensions by field measurement before fabrication; show recorded measurements on shop drawings.

B. Design Engineer's Qualifications: Design structural supports and anchorages under direct supervision of a Structural Engineer experienced in design of this type of work and licensed in Ohio.

C. Manufacturer Qualifications: Company specializing in manufacturing wall panel systems specified in this section.
   1. With not less than three years of documented experience.
   2. Approved by MCM sheet manufacturer.

D. Installer Qualifications: Company specializing in performing work of type specified in this section.
   1. With minimum three years of documented experience.
   2. Approved by wall panel system manufacturer.

E. Testing Agency Qualifications: Independent agency experienced in testing assemblies of the type required for this project and having the necessary facilities for full-size mock-up testing of the type specified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original, unopened, undamaged containers with identification labels intact.
   1. Protect finishes by applying heavy-duty removable plastic film during production.
   2. Package for protection against transportation damage.

3. Provide markings to identify components consistently with drawings.
4. Exercise care in unloading, storing, and installing panels to prevent bending, warping, twisting, and surface damage.

B. Store products protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
1. Store in well-ventilated space out of direct sunlight.
2. Protect from moisture and condensation with tarpaulins or other suitable weathertight covering installed to provide ventilation.
3. Store at a slope to ensure positive drainage of accumulated water.
4. Do not store in enclosed space where ambient temperature can exceed 120 degrees F.
5. Avoid contact with other materials that might cause staining, denting, or other surface damage.

1.7 FIELD CONDITIONS

A. Do not install panels when air temperature or relative humidity are outside manufacturer's limits.

1.8 WARRANTY

A. Special Warranty: Provide 2-year warranty covering water tightness and integrity of seals of wall panels. Complete forms in Owner's name and register with warrantor.

B. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Wall Panel System Manufacturers:
1. ATAS International, Inc; www.atas.com/#sle.
2. Citadel Architectural Products, Inc: www.citadelap.com/#sle.
3. Elevate: www.holcimelevate.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 WALL PANEL SYSTEM

A. Wall Panel System: Metal panels, fasteners, and anchors designed to be supported by framing or other substrate provided by others; provide installed panel system capable of maintaining specified performance without defects, damage, or failure.
1. Provide structural design by or under direct supervision of a Structural Engineer licensed in Ohio.
2. Provide panel jointing and weatherseal using a "wet", sealant-sealed system.
3. Anchor panels to supporting framing without exposed fasteners.

2.3 PERFORMANCE REQUIREMENTS

A. Thermal Movement: Provide for free and noiseless vertical and horizontal thermal movement due to expansion and contraction under material temperature range of minus 20 degrees F to 180 degrees F without buckling, opening of joints, undue stress on fasteners, or other detrimental effects; allow for ambient temperature at time of fabrication, assembly, and erection procedures.

1. Wind Performance: Provide system tested in accordance with ASTM E330/E330M without permanent deformation or failures of structural members under the following conditions:
2. Design Wind Pressure: In accordance with local building code.
3. Maximum deflection of perimeter framing member of L/175 normal to plane of the wall; maximum deflection of individual panels of L/60.
4. Maximum anchor deflection in any direction of 1/16 inch at connection points of framing members to anchors.

B. Air Leakage: 0.10 cfm/sq ft maximum leakage when tested at 1.57 psf pressure difference in accordance with ASTM E283/E283M.

C. Water Penetration: No water penetration under static pressure when tested in accordance with ASTM E331 at a differential of 10 percent of inward acting design load, 6.27 psf minimum, after 15 minutes.
1. Water penetration is defined as the appearance of uncontrolled water on the interior face of the wall.
2. Design to drain leakage and condensation to the exterior face of the wall.

D. Fire Performance: Use test method complying with NFPA 285.

E. Building Envelope Performance: Comply with ASHRAE Std 90.1 I-P when tested as part of building envelope assembly.

2.4 MATERIALS

A. Metal Composite Material (MCM) Sheet: Two sheets of aluminum sandwiching a core of extruded thermoplastic material; no foamed insulation material content.
1. Overall Sheet Thickness: 0.118 inch, minimum.
2. Bond and Peel Strength: No adhesive failure of the bond between the core and the skin nor cohesive failure of the core itself below 22.4 inch-pound/inch with no degradation in bond performance, when tested in accordance with ASTM D1781, simulating resistance to panel delamination, after 8 hours of submersion in boiling water and after 21 days of immersion in water at 70 degrees F.
3. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
4. Flammability: Self-ignition temperature of 650 degrees F or greater when tested in accordance with ASTM D1929.

B. Metal Framing Members: Include sub-girts, zee-clips, base and sill angles and channels, hat-shaped and rigid channels, and furring channels required for complete installation.
1. Provide material strength, dimensions, configuration as required to meet applied loads and in compliance with applicable building code.

2.5 FINISHES

A. Factory Finish: Two coat fluoropolymer resin coating, approved by coating manufacturer for length of warranty specified for project, and applied by coil manufacturing facility that specializes in coil applied finishes.
1. Coating Flexibility: Pass ASTM D4145 minimum 1T Bend at time of manufacturing.
2. Long-Term Performance: Not less than that specified under WARRANTY in PART 1.

B. Finish: Factory finished highly polished Class I natural anodized finish; AAMA 611 AA-M12C22A41, anodic coating not less than 0.7 mil, 0.0007 inch thick.

C. Color/Texture: As selected by Architect from manufacturer's full range.

2.6 ACCESSORIES

A. Flashing: Sheet aluminum; 0.040 inch thick, minimum; finish and color to match MCM sheet; see Section 07 62 00 for additional requirements.

B. Support for Cladding and Continuous Insulation: Thermal clip and rail.
   1. Thermal Clips: Extruded aluminum, with thermal spacer at base and slot at top to allow field adjustment and alignment of rails.
   2. Fasteners: Provide support system and cladding attachment fasteners as recommended by system manufacturer in accordance with requirements.

C. Anchors, Clips, and Accessories: Use one of the following:
   1. Stainless steel complying with ASTM A276/A276M, ASTM A480/A480M, or ASTM A666.
   2. Steel complying with ASTM A36/A36M and hot-dip zinc coating to ASTM A153/A153M.
   3. Steel complying with ASTM A36/A36M and hot-dip galvanized to ASTM A123/A123M, with Coating Thickness Grade of 100.

D. Fasteners:
   1. Exposed Fasteners: Stainless steel; permitted only where absolutely unavoidable and subject to prior approval of the Architect.
   2. Screws: Self-drilling or self-tapping Type 410 stainless steel or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal wall panels.
   3. Bolts: Stainless steel.
   4. Fasteners for Flashing and Trim: Blind fasteners of high-strength aluminum or stainless steel.

E. Joint Sealer: Provide color to match wall panels silicone sealant of type approved by MCM sheet manufacturer, and in compliance with ASTM C920.
   1. See Section 07 92 00 for additional requirements.

F. Provide panel system manufacturer's and installer's standard corrosion resistant accessories, including fasteners, clips, anchorage devices, and attachments.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine dimensions, tolerances, and interfaces with other work.
   1. Verify that weather barrier system is properly installed; see Section 07 25 00 for requirements.

B. Examine substrate on-site to determine that conditions are acceptable for product installation in accordance with manufacturer's written instructions.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

D. Notify Architect in writing of conditions detrimental to proper and timely completion of work, and do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect adjacent work areas and finish surfaces from damage during installation.

3.3 INSTALLATION

A. Do not install products that are defective, including warped, bowed, dented, and broken members, and members with damaged finishes.

B. Comply with instructions and recommendations of MCM sheet manufacturer and wall system manufacturer, as well as with approved shop drawings.

C. Install wall system securely allowing for necessary thermal and structural movement; comply with wall system manufacturer's instructions for installation of concealed fasteners.

D. Do not handle or tool products during erection in manner that damages finish, decreases strength, or results in visual imperfection or failure in performance. Return component parts that require alteration to shop for refabrication, if possible, or for replacement with new parts.

E. Do not form panels in field unless required by wall system manufacturer and approved by the Architect; comply with MCM sheet manufacturer's instructions and recommendations for field forming.

F. Separate dissimilar metals; use gasket fasteners, isolation shims, or isolation tape where needed to eliminate possibility of electrolytic action between metals.

G. Where joints are designed for field-applied sealant, seal joints completely with specified sealant.

H. Install flashings as indicated on shop drawings. At flashing butt joints, provide a lap strap under flashing and seal lapped surfaces with a full bed of non-hardening sealant.

I. Install square, plumb, straight, and true, accurately fitted, with tight joints and intersections maintaining the following installation tolerances:
   1. Variation From Plane or Location: 1/2 inch in 30 feet of length and up to 3/4 inch in 300 feet, maximum.
   2. Deviation of Vertical Member From True Line: 0.1 inch in 25 feet run, maximum.
   3. Deviation of Horizontal Member From True Line: 0.1 inch in 25 feet run, maximum.
   4. Offset From True Alignment Between Two Adjacent Members Abutting End To End, In Line: 0.03 inch, maximum.

J. Replace damaged products.

3.4 FIELD QUALITY CONTROL

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

B. Wall System Manufacturer's Field Services: Provide field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with instructions.

C. Site Visits: Schedule at least one site visit during execution of installation.

3.5 CLEANING

A. Ensure weep holes and drainage channels are unobstructed and free of dirt and sealants.

B. Remove protective film after installation of joint sealers, after cleaning of adjacent materials, and immediately prior to completion of work.

C. Remove temporary coverings and protection of adjacent work areas.

D. Clean installed products in accordance with manufacturer's instructions.

3.6 PROTECTION

A. Protect installed panel system from damage until Date of Substantial Completion.

END OF SECTION 07 42 13.23

SECTION 07 46 46
FIBER-CEMENT SIDING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fiber-cement siding.

1.2 RELATED REQUIREMENTS

A. Section 05 40 00 - Cold-Formed Metal Framing: Siding substrate.

B. Section 06 10 00 - Rough Carpentry: Siding substrate.

C. Section 07 25 00 - Weather Barriers: Water-resistive barrier under siding.

D. Section 07 92 00 - Joint Sealants: Sealing joints between siding and adjacent construction and fixtures.

E. Section 09 91 13 - Exterior Painting: Field painting.

1.3 REFERENCE STANDARDS

A. ASTM C1186 - Standard Specification for Flat Fiber-Cement Sheets; 2022, with Editorial Revision (2023).

1.4 SUBMITTALS

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

B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
   1. Manufacturer's requirements for related materials to be installed by others.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods, including nail patterns.

C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, _____, and methods of anchorage.

D. Test Report: Applicable model code authority evaluation report (e.g. ICC-ES).

E. Manufacturer's qualification statement.

F. Installer's qualification statement.

G. Maintenance Instructions: Periodic inspection recommendations and maintenance procedures.

H. Warranty: Submit copy of manufacturer's warranty, made out in Owner's name, showing that it has been registered with manufacturer.

1.5 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 type specified in this section with not less than three years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Deliver and store materials in manufacturer's unopened packaging, with labels intact, until ready for installation.

C. Store materials under dry and waterproof cover, well ventilated, and elevated above grade on a flat surface.

D. Protect materials from harmful environmental elements, construction dust, and other potentially detrimental conditions.

1.7 FIELD CONDITIONS

A. Do not install panels when air temperature or relative humidity are outside manufacturer's limits.

1.8 WARRANTY

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

B. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.1 FIBER-CEMENT SIDING

A. Lap Siding: Individual horizontal boards made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C1186, Type A, Grade II; with machined edges, for nail attachment.
   1. Style: Standard lap style.
   2. Texture: Simulated cedar grain.
   3. Length: 12 feet, nominal.
   4. Width (Height): Varies, refer to drawings.
   5. Thickness: 5/16 inch, nominal.
   6. Finish: Factory applied primer.
   7. Warranty: 50 year limited; transferable.
   8. Products:
      a. Basis of Design: Allura, a division of Plycem USA, Inc: www.allurausa.com/#sle.
      b. James Hardie Building Products, Inc: www.jameshardie.com/#sle.
      c. Nichiha USA, Inc: www.nichiha.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 ACCESSORIES

A. Trim: Same material and texture as siding.

B. Fasteners: Galvanized or corrosion resistant; length as required to penetrate, 1-1/4 inches, minimum.

C. Sealant: Elastomeric, polyurethane or silyl-terminated polyether/polyurethane, and capable of being painted.

D. Finish Paint: Latex house paint acceptable to siding manufacturer; primer recommended by paint manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrate, clean and repair as required to eliminate conditions that would be detrimental to proper installation.

B. Verify that water-resistant barrier has been installed over substrate completely and correctly; see Section 05 40 00.

C. Do not begin until unacceptable conditions have been corrected.

D. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Protect surrounding areas and adjacent surfaces during execution of this work.

B. Install Sheet Metal Flashing:
   1. Above door and window trim and casings.

3.3 INSTALLATION

A. Install siding in accordance with manufacturer's instructions and recommendations.
   1. Read warranty and comply with terms necessary to maintain warranty coverage.
   2. Install in accordance with conditions stated in model code evaluation report applicable to location of project.
   3. Use trim details as indicated on drawings.
   4. Touch up field cut edges before installing.
   5. Pre-drill nail holes if necessary to prevent breakage.

B. Over Steel Studs: Use hot-dipped galvanized self-tapping screws, with the points of at least three screws penetrating each stud the panel crosses and at panel ends.

C. Allow space for thermal movement between both ends of siding panels that butt against trim; seal joint between panel and trim with specified sealant.

D. Joints in Horizontal Siding: Avoid joints in lap siding except at corners; where joints are inevitable stagger joints between successive courses.

E. Do not install siding less than 6 inches from ground surface, or closer than 1 inch to roofs, patios, porches, and other surfaces where water may collect.

F. After installation, seal joints except lap joints of lap siding; seal around penetrations, and paint exposed cut edges.

G. Finish Painting: See Section 09 91 13.

H. Finish Painting: Within one week after installation, paint siding and trim with one coat primer and two coats finish paint.

3.4 CLEANING

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

B. Clean faced panels in accordance with manufacturer's maintenance instructions, using cleaning materials and methods acceptable to manufacturer.

3.5 PROTECTION

A. Protect installed products until Date of Substantial Completion.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 07 46 46

SECTION 07 53 00
ELASTOMERIC MEMBRANE ROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Elastomeric roofing membrane application.

B. Insulation, tapered.

C. Vapor retarder.

D. Deck sheathing.

E. Cover boards.

F. Roofing cant strips.

1.2 RELATED REQUIREMENTS

A. Section 05 31 00 - Steel Decking

B. Section 06 10 00 - Rough Carpentry

1.3 REFERENCE STANDARDS

A. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.

B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2023a.

C. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers; 2000 (Reapproved 2020).

D. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).

E. ASTM D4637/D4637M - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane; 2015, with Editorial Revision (2022).

F. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces; 2011 (Reapproved 2019).

G. FM (AG) - FM Approval Guide; Current Edition.

H. FM DS 1-28 - Wind Design; 2015, with Editorial Revision (2022).

I. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

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

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of associated counterflashings installed under other sections.

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

1.5 SUBMITTALS

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

B. Product Data: Provide data indicating membrane materials, flashing materials, surfacing, and fasteners.

C. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, setting plan for tapered insulation, and mechanical fastener layout.

D. Samples for Verification: Submit two samples 12 by 12 inches in size illustrating insulation.

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

F. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.

G. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.

H. Sustainable Design Documentation: Test report showing solar reflectance index of membrane.

I. Manufacturer's qualification statement.

J. Installer's qualification statement.

K. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

B. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact.

C. Store materials in weather protected environment, clear of ground and moisture.

D. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.

E. Protect foam insulation from direct exposure to sunlight.

1.8 FIELD CONDITIONS

A. Do not apply roofing membrane during unsuitable weather.

B. Do not apply roofing membrane when ambient temperature is below 40 degrees F or above 90 degrees F or as limited by manufacturer's instructions.

C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

E. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.9 WARRANTY

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

B. Correct defective work within a two year period after Date of Substantial Completion.

C. Provide five year manufacturer's material and labor warranty to cover failure to prevent penetration of water.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. EPDM Membrane Materials:
   1. Carlisle SynTec Systems: www.carlisle-syntec.com/#sle.
   2. Basis of Design: Elevate: www.holcimelevate.com/#sle.
   3. GenFlex Roofing Systems, LLC: www.genflex.com/#sle.
   4. Johns Manville: www.jm.com/#sle.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation:
   1. Dow: www.dow.com/#sle.
   2. GAF: www.gaf.com/#sle.
   3. Owens Corning Corporation: www.owenscorning.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 ROOFING - UNBALLASTED APPLICATIONS

A. Elastomeric Membrane Roofing: One ply membrane, fully adhered, over vapor retarder and insulation.

B. Roofing Assembly Requirements:

1. Solar Reflectance Index (SRI): 78, minimum, calculated in accordance with ASTM E1980, based on 3-year aged data.
   a. Field applied coating may not be used to achieve specified SRI.
2. Roof Covering External Fire Resistance Classification: UL (DIR) certified Class A.
3. Factory Mutual Classification: Class 1 and windstorm resistance of 1-90, in accordance with FM DS 1-28.
4. Insulation Thermal Resistance (R-Value): 6 per inch, minimum; provide insulation of thickness required.

C. Acceptable Insulation Types:
   1. Tapered polyisocyanurate board.

2.3 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

A. Membrane: Ethylene-propylene-diene-monomer (EPDM); non-reinforced; complying with minimum properties of ASTM D4637/D4637M.
   1. Thickness: 60 mil, 0.060 inch, minimum.
   2. Sheet Width: 120 inches, maximum.
   3. Thermal Emittance: 0.84, minimum, initial, and 0.87, minimum, 3-year, certified by Cool Roof Rating Council.
   4. Color: White.
   5. Durometer Hardness, Type A: 30, minimum, in accordance with ASTM D2240
   6. Tear Strength: 150 lbf per inch, measured in accordance with ASTM D624.

B. Seaming Materials: As recommended by membrane manufacturer.

C. Membrane Fasteners: As recommended by and approved by membrane manufacturer.

D. Vapor Retarder: Reinforced Kraft paper laminate, complying with requirements of fire rating classification; compatible with roofing and insulation materials.
   1. Fire-retardant adhesive.

E. Flexible Flashing Material: Same material as membrane.

2.4 DECK SHEATHING

A. Deck Sheathing: Glass mat faced gypsum panels, ASTM C1177/C1177M, fire resistant type, 5/8 inch thick.
   1. Thickness: 5/8 inch, Type X, fire-resistant.
   2. Products:
      a. Georgia-Pacific: www.densdeck.com/#sle.
      b. USG Corporation: www.usg.com/#sle.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

2.5 COVER BOARDS

A. Cover Boards: Glass-mat faced gypsum panels complying with ASTM C1177/C1177M.
   1. Thickness: 1/2 inch, fire-resistant.
   2. FM classified for Very Severe Hail (VSH) in approved single ply membrane assemblies.
   3. Products:
      a. Georgia-Pacific: www.densdeck.com/#sle.
      b. USG Corporation..
      c. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 INSULATION

A. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, complying with ASTM C1289.
   1. Classifications:
      a. Type I: Faced with aluminum foil on both major surfaces of the core foam.
         1) Class 1 - Non-reinforced core foam.
         2) Compressive Strength: 16 psi, minimum.
         3) Thermal Resistance, R-value: At 1-1/2 inch thick; 9.0 at 75 degrees F.
   2. Board Size: 48 by 96 inches.
   3. Tapered Board: Slope as indicated; minimum thickness 2 inch; fabricate of fewest layers possible.
   4. Board Edges: Square.
   5. Products:
      a. Dow Chemical Company: www.dow.com/#sle.
      b. GAF; : www.gaf.com/#sle.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

2.7 ACCESSORIES

A. Cant Strips: Wood; pressure preservative treated.

B. Sheathing Joint Tape: Paper type, 2 inches wide, self adhering.

C. Insulation Fasteners: Appropriate for purpose intended.
   1. Length as required for thickness of insulation material and penetration of deck substrate.

D. Membrane Adhesive: As recommended by membrane manufacturer.

E. Thinners and Cleaners: As recommended by adhesive manufacturer, compatible with membrane.

F. Insulation Adhesive: As recommended by insulation manufacturer.

G. Roofing Nails: Galvanized, hot-dipped type, size and configuration as required to suit application.

H. Sealants: As recommended by membrane manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.

B. Verify deck is supported and secure.

C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.

D. Verify deck surfaces are dry and free of snow or ice.

E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.2 PREPARATION - METAL DECK

A. Install deck sheathing on metal deck.
   1. Lay with long side at right angle to flutes; stagger end joints; provide support at ends.
   2. Cut sheathing cleanly and accurately at roof breaks and protrusions to provide smooth surface.
   3. Tape joints.

B. Mechanically fasten sheathing to roof deck, in accordance with Factory Mutual recommendations and roofing manufacturer's instructions.
   1. Over entire roof area, fasten sheathing using six fasteners with washers per sheathing board.

3.3 INSTALLATION - VAPOR RETARDER AND INSULATION, UNDER MEMBRANE

A. Install vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
   1. Extend vapor retarder under cant strips and blocking to deck edge.
   2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.

B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.

C. Attachment of Insulation:
   1. Embed first layer of insulation in full bed of adhesive in accordance with roofing and insulation manufacturers' instructions.
   2. Mechanically fasten first layer for distance of minimum 48 inches from roof edge.
   3. Mechanically fasten each subsequent layer of insulation to deck in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.

D. Cover Boards: Mechanically fasten cover boards in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.

E. Lay subsequent layers of insulation with joints staggered minimum 6 inches from joints of preceding layer.

F. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.

G. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.

H. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.

I. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 18 inches.

J. Do not apply more insulation than can be covered with membrane in same day.

3.4 INSTALLATION - MEMBRANE

A. Install elastomeric membrane roofing system in accordance with manufacturer's recommendations and NRCA (WM) applicable requirements.

B. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.

C. Shingle joints on sloped substrate in direction of drainage.

D. Fully Adhered Application: Fully embed membrane in adhesive except in areas directly over or within 3 inches of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.

E. Overlap edges and ends and seal seams by contact tape or contact adhesive, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.

F. At intersections with vertical surfaces:
   1. Extend membrane over cant strips and up a minimum of 8 inches onto vertical surfaces.
   2. Fully adhere flexible flashing over membrane and up to nailing strips.

G. Around roof penetrations, seal flanges and flashings with flexible flashing.

H. Coordinate installation of roof drains and sumps and related flashings.

3.5 FIELD QUALITY CONTROL

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

B. Provide daily on-site attendance of roofing and insulation manufacturer's representative during installation of this work.

3.6 CLEANING

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

B. Remove bituminous markings from finished surfaces.

C. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.

D. Repair or replace defaced or damaged finishes caused by work of this section.

3.7 PROTECTION

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION 07 53 00

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fabricated sheet metal items, including flashings, counterflashings, downspouts, scuppers, copings, and other items indicated in Schedule.

B. Sealants for joints within sheet metal fabrications.

C. Precast concrete splash pads.(roof)

1.2 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 B32 - Standard Specification for Solder Metal; 2020.

D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

E. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction; 2022.

F. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

G. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2017 (Reapproved 2023).

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.

1.3 SUBMITTALS

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

B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

C. Samples: Submit two samples, 6 by 6 inches in size, illustrating metal finish color.

1.4 QUALITY ASSURANCE

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

B. Maintain one copy of each document on site.

C. Fabricator and Installer Qualifications: Company specializing in sheet metal work with three years of documented experience.

1.5 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

2.1 SHEET MATERIALS

A. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal, shop pre-coated with PVDF coating.
   1. Polyvinylidene Fluoride (PVDF) Coating: Superior performing organic powder coating, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
   2. Color: As selected by Architect from manufacturer's standard colors.

B. Anodized Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 20 gauge, 0.032 inch thick; clear anodized finish.

C. Copper: ASTM B370, cold rolled 16 oz/sq ft, 24 gauge, 0.0216 inch thick; natural finish.

2.2 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Form pieces in longest possible lengths.

C. Hem exposed edges on underside 1/2 inch; miter and seam corners.

D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

E. Fabricate corners from one piece with minimum 18-inch long legs; seam for rigidity, seal with sealant.

F. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

G. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.3 SCUPPERS AND DOWNSPOUTS

A. Downspouts for scuppers: Round profile.

B. Scuppers and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA (ASMM).

C. Accessories: Profiled to suit scuppers and downspouts.
   1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
   2. Downspout Supports: Brackets.

D. Splash Pads: Precast concrete type; minimum 3,000 psi at 28 days, with minimum 5 percent air entrainment. Provide protection membrane as recommended by membrane roof provider under all splash pads.

E. Seal metal joints.

2.4 ACCESSORIES

A. Fasteners: Galvanized steel, with soft neoprene washers.

B. Underlayment: ASTM D226/D226M, organic roofing felt, Type I, No. 15.

C. Slip Sheet: Rosin-sized sheathing paper.

D. Primer Type: Zinc chromate.

E. Protective Backing Paint: Zinc molybdate alkyd.

F. Concealed Sealants: Non-curing butyl sealant.

G. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.

H. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

I. Reglets: Recessed type, galvanized steel; face and ends covered with plastic tape.

J. Solder: ASTM B32, Alloy Grade - Sn50 (50/50).

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 INSTALLATION

A. Insert flashings into reglets to form tight fit; secure in place with lead wedges; pack remaining spaces with lead wool; seal flashings into reglets with sealant.

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

C. Apply plastic cement compound between metal flashings and felt flashings.

D. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.

E. Solder metal joints for full metal surface contact, and after soldering wash metal clean with neutralizing solution and rinse with water.

F. Secure scuppers and downspouts in place with{CH#45424} fasteners.

G. Set splash pads under downspouts.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Control Services for field inspection requirements.

B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

3.5 SCHEDULE

A. Fascia and Cornices:

B. Downspouts:

C. Scuppers:

D. Coping, Cap, Parapet, Sill and Ledge Flashings:

E. Counterflashings at Roofing Terminations (over roofing base flashings):

F. Counterflashings at Curb-Mounted Roof Items, including skylights and roof hatches:

G. Roofing Penetration Flashings, for Pipes, Structural Steel, and Equipment Supports:

END OF SECTION 07 62 00

SECTION 07 72 00
ROOF ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Roof hatches.

1.2 REFERENCE STANDARDS

1.3 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.

D. Warranty Documentation:
   1. Submit manufacturer warranty.
   2. Ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 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.

1.5 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.

PART 2 PRODUCTS

2.1 ROOF HATCHES AND VENTS, MANUAL AND AUTOMATIC OPERATION

A. Roof Hatch Manufacturers:
   1. Acudor Products Inc: www.acudor.com/#sle.
   2. Babcock-Davis: www.babcockdavis.com/#sle.
   3. Bilco Company: www.bilco.com/#sle.
   4. Nystrom, Inc: www.nystrom.com/#sle.

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

B. Roof Hatches: Factory-assembled aluminum 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 standing seam metal roof panel system.
   3. Thermally Broken Hatches: Provide insulation within frame and cover.
   4. Size: As indicated on drawings; single-leaf style unless otherwise indicated.
   5. For Ladder Access: Single leaf; 30 by 36 inches.

C. Frames and Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
   1. Material: Mill finished aluminum, 11 gauge, 0.0907 inch thick.
   2. Insulation: Manufacturer's standard; 1 inch rigid glass fiber, located on outside face of curb.

D. Metal Covers: Flush, insulated, hollow metal construction.
   1. Capable of supporting 40 psf live load.
   2. Material: Mill finished aluminum; outer cover 11 gauge, 0.0907 inch thick, liner 0.04 inch thick.
   3. Insulation: Manufacturer's standard 1 inch rigid glass fiber.
   4. Gasket: Neoprene, continuous around cover perimeter.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.3 INSTALLATION

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

3.4 CLEANING

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

B. Clean installed work to like-new condition.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 07 72 00

SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nonsag gunnable joint sealants.

B. Self-leveling pourable joint sealants.

C. Joint backings and accessories.

1.2 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.

1.3 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 C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

E. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2023.

F. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).

G. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2022.

H. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints; 2019 (Reapproved 2020).

I. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).

J. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

1.4 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. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
   4. Substrates the product should not be used on.
   5. Substrates for which use of primer is required.
   6. Substrates for which laboratory adhesion and/or compatibility testing is required.
   7. Installation instructions, including precautions, limitations, and recommended backing materials and tools.
   8. Sample product warranty.
   9. Certification by manufacturer indicating that product complies with specification requirements.

C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.

D. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.

E. Sustainable Design Documentation: For sealants and primers, submit VOC content and emissions documentation; see Section 01 61 16.

F. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.

G. Installation Plan: Submit at least four weeks prior to start of installation.

H. Preinstallation Field Adhesion Test Plan: Submit at least two weeks prior to start of installation.

I. Field Quality Control Plan: Submit at least two weeks prior to start of installation.

J. Preinstallation Field Adhesion Test Reports: Submit filled out Preinstallation Field Adhesion Test Reports log within 10 days after completion of tests; include bagged test samples and photographic records.

K. Installation Log: Submit filled-out log for each length or instance of sealant installed.

L. Field Quality Control Log: Submit filled-out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.

M. Manufacturer's qualification statement.

N. Installer's qualification statement.

O. Executed warranty.

1.5 QUALITY ASSURANCE

A. Maintain one copy of each referenced document covering installation requirements on site.

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

C. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience.

D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

E. 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.

F. Installation Plan: Include schedule of sealed joints, including the following:
   1. Joint width indicated in Contract Documents.
   2. Joint depth indicated in Contract Documents; to face of backing material at centerline of joint.
   3. Method to be used to protect adjacent surfaces from sealant droppings and smears, with acknowledgment that some surfaces cannot be cleaned to like-new condition and therefore prevention is imperative.
   4. Approximate date of installation, for evaluation of thermal movement influence.
   5. Installation Log Form: Include the following data fields, with known information filled out.
      a. Unique identification of each length or instance of sealant installed.
      b. Location on project.
      c. Substrates.
      d. Sealant used.
      e. Stated movement capability of sealant.
      f. Primer to be used, or indicate no primer is used.
      g. Size and actual backing material used.
      h. Date of installation.
      i. Name of installer.
      j. Actual joint width; provide space to indicate maximum and minimum width.
      k. Actual joint depth to face of backing material at centerline of joint.
      l. Air temperature.

G. Preinstallation Field Adhesion Test Plan: Include destructive field adhesion testing of one sample of each combination of sealant type and substrate, except interior acrylic latex sealants, and include the following for each tested sample.
   1. Identification of testing agency.
   2. Preinstallation Field Adhesion Test Log Form: Include the following data fields, with known information filled out.
      a. Substrate; if more than one type of substrate is involved in a single joint, provide two entries on form, for testing each sealant substrate side separately.
      b. Test date.

c. Location on project.
d. Sealant used.
e. Stated movement capability of sealant.
f. Test method used.
g. Date of installation of field sample to be tested.
h. Copy of test method documents.
i. Age of sealant upon date of testing.
j. Test results, modeled after the sample form in the test method document.
k. Indicate use of photographic record of test.

H. Field Quality Control Plan:
1. Visual inspection of entire length of sealant joints.
2. Nondestructive field adhesion testing of sealant joints, except interior acrylic latex sealants.
a. Test the entire length of every sealant joint.
3. Destructive field adhesion testing of sealant joints, except interior acrylic latex sealant.
a. For each different sealant and substrate combination, allow for one test every 100 feet in the first 1,000 linear feet, and one test per 1,000 linear feet thereafter, or once per floor on each elevation.
b. If any failures occur in the first 1,000 linear feet, continue testing at frequency of one test per 500 linear feet at no extra cost to Owner.
4. Field testing agency's qualifications.
5. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.

I. Field Adhesion Test Procedures:
1. Allow sealants to fully cure as recommended by manufacturer before testing.
2. Have a copy of the test method document available during tests.
3. Take photographs or make video records of each test, with joint identification provided in the photos/videos; for example, provide small erasable whiteboard positioned next to joint.
4. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
5. When performing destructive tests, also inspect the opened joint for proper installation characteristics recommended by manufacturer, and report any deficiencies.
6. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.

J. Field Adhesion Tests of Joints: Test for adhesion using most appropriate method in accordance with ASTM C1521, or another applicable method as recommended by manufacturer.

1.6 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.

C. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Nonsag Sealants:
   1. Dow: www.dow.com/#sle.
   2. Master Builders Solutions: www.master-builders-solutions.com/en-us/#sle.
   3. Pecora Corporation: www.pecora.com/#sle.
   4. Sika Corporation: www.usa.sika.com/#sle.
   5. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.
   6. Substitutions: See Section 01 60 00 - Product Requirements.

B. Self-Leveling Sealants:
   1. Dow: www.dow.com/#sle.
   2. Master Builders Solutions: www.master-builders-solutions.com/en-us/#sle.
   3. Pecora Corporation: www.pecora.com/#sle.
   4. Sika Corporation: www.usa.sika.com/#sle.
   5. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.
   6. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 JOINT SEALANT APPLICATIONS

A. Scope:
   1. Do Not Seal:
      a. Intentional weep holes in masonry.
      b. Joints indicated to be covered with expansion joint cover assemblies.
      c. Joints where sealant is specified to be furnished and installed by manufacturer of product to be sealed.
      d. Joints where sealant installation is specified in other sections.
      e. Joints between suspended ceilings and walls.

B. Exterior Joints: Use nonsag nonstaining silicone sealant, unless otherwise indicated.
   1. Wall and Ceiling Joints in Nonwet Areas: Acrylic emulsion latex sealant.
   2. Wall and Ceiling Joints in Wet Areas: Nonsag polyurethane sealant for continuous liquid immersion.
   3. Joints between Tile in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.

C. Interior Wet Areas: Bathrooms and restrooms; fixtures in wet areas include plumbing fixtures, countertops, cabinets, and other similar items.

2.3 JOINT SEALANTS - GENERAL

A. Sealants and Primers: Provide products with acceptable levels of volatile organic compound (VOC) content; see Section 01 61 16.

2.4 NONSAG JOINT SEALANTS

A. Nonstaining 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. Nonstaining to Porous Stone: Nonstaining to light-colored natural stone when tested in accordance with ASTM C1248.
3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
4. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
5. Color: To be selected by Architect from manufacturer's standard range.
6. Cure Type: Single-component, neutral moisture curing.
7. Service Temperature Range: Minus 20 to 180 degrees F.
8. Products:
   a. Dow; DOWSIL 795 Silicone Building Sealant: www.dow.com/#sle.
   b. Pecora Corporation; Pecora 890 NST (Non-Staining Technology): www.pecora.com/#sle.
   c. Sika Corporation; Sikasil WS-290: www.usa.sika.com/#sle.
   d. Sika Corporation; Sikasil WS-295: www.usa.sika.com/#sle.
   e. Tremco Commercial Sealants & Waterproofing; Spectrem 1: www.tremcosealants.com/#sle.
   f. Tremco Commercial Sealants & Waterproofing; Spectrem 2: www.tremcosealants.com/#sle.
   g. Substitutions: See Section 01 60 00 - Product Requirements.

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: To be selected by Architect from manufacturer's standard range.
   4. Cure Type: Single component, neutral moisture curing.
   5. Service Temperature Range: Minus 65 to 180 degrees F.
   6. Products:
      a. Dow; DOWSIL 758 Silicone Weather Barrier Sealant: www.dow.com/#sle.
      b. Pecora Corporation; Pecora 860: www.pecora.com/#sle.
      c. Sika Corporation; Sikasil WS-295: www.usa.sika.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

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. Pecora Corporation; Pecora 898 NST (Non-Staining Technology): www.pecora.com/#sle.
      b. Sika Corporation; Sikasil GP: www.usa.sika.com/#sle.
      c. Substitutions: See Section 01 60 00 - Product Requirements.
   3. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
   4. Color: To be selected by Architect from manufacturer's standard range.
   5. Service Temperature Range: Minus 40 to 180 degrees F.
   6. Products:
      a. Master Builders Solutions; MasterSeal NP1: www.master-builders-solutions.com/en-us/#sle.
      b. Pecora Corporation; DynaFlex: www.pecora.com/#sle.
      c. Sika Corporation; Sikaflex-2c NS: www.usa.sika.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

D. 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: To be selected by Architect from manufacturer's standard range.
4. Service Temperature Range: Minus 40 to 180 degrees F.
5. Products:
   a. Sika Corporation; Sikaflex-2c NS: www.usa.sika.com/#sle.
   b. Substitutions: See Section 01 60 00 - Product Requirements.

E. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.
1. Color: To be selected by Architect from manufacturer's standard range.
2. Grade: ASTM C834; Grade 0 Degrees F (Minus 18 Degrees C).
3. Products:
   a. Pecora Corporation; AC-20 +Silicone: www.pecora.com/#sle.
   b. Tremco Commercial Sealants & Waterproofing; Tremflex 834: www.tremcosealants.com/#sle.
   c. Substitutions: See Section 01 60 00 - Product Requirements.

2.5 SELF-LEVELING JOINT SEALANTS

A. Self-Leveling Polyurethane Sealant for Horizontal Expansion Joints: ASTM C920, Grade P, Uses T, M, and O; multicomponent; explicitly approved by manufacturer for horizontal expansion joints.
1. Movement Capability: Plus and minus 25 percent, minimum.
2. Hardness Range: 30 to 35, Shore A, when tested in accordance with ASTM C661.
3. Color: To be selected by Architect from manufacturer's standard range.
4. Tensile Strength: 200 to 250 psi in accordance with ASTM D412.
5. Products:
   a. Pecora Corporation; DynaTrol II-SG (Slope Grade): www.pecora.com/#sle.
   b. Pecora Corporation; Urexpan NR-200: www.pecora.com/#sle.
   c. Tremco Commercial Sealants & Waterproofing; ____: www.tremcosealants.com/#sle.
   d. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 ACCESSORIES

A. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.

B. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.

C. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.

D. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

C. Preinstallation Adhesion Testing: Install a sample for each test location indicated in the test plan.
   1. Test each sample as specified in PART 1 under QUALITY ASSURANCE article.
   2. Notify Architect of date and time that tests will be performed, at least seven days in advance.
   3. Record each test on Preinstallation Adhesion Test Log as indicated.
   4. If any sample fails, review products and installation procedures, consult manufacturer, or take other measures that are necessary to ensure adhesion; retest in a different location; if unable to obtain satisfactory adhesion, report to Architect.
   5. After completion of tests, remove remaining sample material and prepare joints for new sealant installation.

3.2 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.

E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in an inconspicuous area to verify that it does not stain or discolor slab.

3.3 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 bond breaker backing tape where backer rod cannot be used.

D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.

E. 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.

F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.4 FIELD QUALITY CONTROL

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

B. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.

C. Non-Destructive Adhesion Testing: If there are any failures in first 100 linear feet, notify Architect immediately.

D. Destructive Adhesion Testing: If there are any failures in first 1,000 linear feet, notify Architect immediately.

E. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

F. Repair destructive test location damage immediately after evaluation and recording of results.

3.5 POST-OCCUPANCY

A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width, i.e., at low temperature in thermal cycle. Report failures immediately and repair them.

END OF SECTION 07 92 00

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Non-fire-rated hollow metal doors and frames.

B. Hollow metal frames for wood doors.

C. Thermally insulated hollow metal doors with frames.

1.2 RELATED REQUIREMENTS

A. Section 08 71 00 - Door Hardware.

B. Section 08 80 00 - Glazing: Glass for doors.

C. Section 09 91 23 - Interior Painting: Field painting.

1.3 ABBREVIATIONS AND ACRONYMS

A. ANSI: American National Standards Institute.

B. ASCE: American Society of Civil Engineers.

C. HMMA: Hollow Metal Manufacturers Association.

D. NAAMM: National Association of Architectural Metal Manufacturers.

E. NFPA: National Fire Protection Association.

F. SCIF: Sensitive Compartmented Information Facility.

G. SDI: Steel Door Institute.

H. UL: Underwriters Laboratories.

1.4 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.

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. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.

I. ASTM C476 - Standard Specification for Grout for Masonry; 2023.

J. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.

K. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

L. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.

M. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2011.

N. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2017.

O. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.

P. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames; 2023.

1.5 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 any indicated finish requirements.

D. Samples: Submit two samples of metal, 2 by 2 inches in size, showing factory finishes, colors, and surface texture.

E. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

F. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

G. Manufacturer's Qualification Statement.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.

B. Maintain at project site copies of reference standards relating to installation of products specified.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Hollow Metal Doors and Frames:
   1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com/#sle.
   2. Curries, an Assa Abloy Group company: www.assaabloydss.com/#sle.
   3. Republic Doors, an Allegion brand: www.republicdoor.com/#sle.
   4. Steelcraft, an Allegion brand: www.allegion.com/#sle.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 PERFORMANCE REQUIREMENTS

A. Requirements for Hollow Metal Doors and Frames:
   1. Steel Sheet: Comply with one or more of the following requirements; galvannealed steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
   2. Accessibility: Comply with ICC A117.1 and ADA Standards.
   3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
   4. Door Edge Profile: Manufacturers standard for application indicated.
   5. Typical Door Face Sheets: Flush.
   6. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
   7. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
   8. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.
      a. Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.

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

2.3 HOLLOW METAL DOORS

A. Door Finish: Factory primed and field finished.

B. Exterior Doors: Thermally insulated.
   1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
      a. Level 3 - Extra Heavy-duty.
      b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
      c. Model 1 - Full Flush.
      d. Door Face Metal Thickness: 16 gauge, 0.053 inch, minimum.
   2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
   3. Door Thickness: 1-3/4 inches, nominal.

C. Interior Doors, Non-Fire-Rated:
   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. Model 1 - Full Flush.
      d. Door Face Metal Thickness: 18 gauge, 0.042 inch, minimum.
   2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
   3. Door Thickness: 1-3/4 inches, nominal.

2.4 HOLLOW METAL FRAMES

A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.

B. Frame Finish: Factory primed and field finished.

C. Exterior Door Frames: Full profile/continuously welded type.
   1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
   2. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
   3. Weatherstripping: Separate, see Section 08 71 00.

D. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
   1. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.

E. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.

F. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.

G. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.

2.5 FINISHES

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

B. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15 mil, 0.015 inch dry film thickness (DFT) per coat; provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.6 ACCESSORIES

A. Glazing: As specified in Section 08 80 00, factory installed.

B. Grout for Frames: Mortar grout complying with ASTM C476 with maximum slump of 4 inches as measured in accordance with ASTM C143/C143M for hand troweling in place; plaster grout and thinner pumpable grout are prohibited.

C. 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.

D. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.1 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.

3.2 PREPARATION

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

3.3 INSTALLATION

A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.

B. Coordinate frame anchor placement with wall construction.

C. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.

D. Install door hardware as specified in Section 08 71 00.

E. Comply with glazing installation requirements of Section 08 80 00.

F. Coordinate installation of electrical connections to electrical hardware items.

3.4 TOLERANCES

A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.

B. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.5 ADJUSTING

A. Adjust for smooth and balanced door movement.

3.6 SCHEDULE

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

END OF SECTION 08 11 13

SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

A. Section 08 11 13 - Hollow Metal Doors and Frames.

B. Section 08 71 00 - Door Hardware.

C. Section 08 80 00 - Glazing.

D. Section 09 21 16 - Gypsum Board Assemblies

1.3 REFERENCE STANDARDS

A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

1.4 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, 12 by 12 inches in size illustrating wood grain, stain color, and sheen.

E. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

F. Manufacturer's Installation Instructions: Indicate special installation instructions.

G. Manufacturer's qualification statement.

H. Specimen warranty.

I. Warranty, executed in Owner's name.

1.5 QUALITY ASSURANCE

A. Maintain one copy of the specified door quality standard on site for review during installation and finishing.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.

1.6 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.

1.7 WARRANTY

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

B. Manufacturer Warranty: Provide manufacturer's warranty on interior doors for the life of the installation. Complete forms in Owner's name and register with manufacturer.
   1. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Wood Veneer Faced Doors:
   1. Masonite Architectural: www.architectural.masonite.com/#sle.
   2. Basis of Design: VT Industries, Inc: www.vtindustries.com/#sle.
   3. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 DOORS

A. Doors: See drawings for locations and additional requirements.
   1. Quality Standard: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
   2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.

B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
   1. Provide solid core doors at each location.
   2. Wood veneer facing with factory transparent finish.

2.3 DOOR AND PANEL CORES

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

2.4 DOOR FACINGS

A. Veneer Facing for Transparent Finish: Natural birch, 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.
   1. "Running Match" each pair of doors and doors in close proximity to each other.

B. Facing Adhesive: Type I - waterproof.

2.5 DOOR CONSTRUCTION

A. Fabricate doors in accordance with door quality standard specified.

B. Cores Constructed with stiles and rails:
   1. Provide solid blocks at lock edge for hardware reinforcement.
   2. Provide solid blocking for other throughbolted hardware.

C. Where supplementary protective edge trim is required, install trim after veneer facing has been applied full-width.

D. Glazed Openings: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.

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.

2.6 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 - 9, UV Curable, Acrylated Epoxy, Polyester or Urethane.
      b. Stain: As selected by Architect.
      c. Sheen: Satin.

B. Factory finish doors in accordance with approved sample.

C. Seal door top edge with color sealer to match door facing.

2.7 ACCESSORIES

A. Hollow Metal Door Frames: See Section 08 11 13.

B. Glazing: See Section 08 80 00.

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

3.1 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.

3.2 INSTALLATION

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

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.

3.3 TOLERANCES

A. Comply with specified quality standard for fit and clearance tolerances.

B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.4 ADJUSTING

A. Adjust doors for smooth and balanced door movement.

B. Adjust closers for full closure.

3.5 SCHEDULE

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

END OF SECTION 08 14 16

SECTION 08 43 13
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aluminum-framed storefront, with vision glass.

B. Aluminum doors.

C. Weatherstripping.

D. Door hardware.

1.2 RELATED REQUIREMENTS

A. Section 08 42 29 - Automatic Entrances.

B. Section 08 71 00 - Door Hardware: Hardware items other than specified in this section.

C. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.3 REFERENCE STANDARDS

A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.

B. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2015.

C. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.

D. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.

E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

G. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

H. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

I. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

J. ASTM 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.

K. 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).

L. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

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

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.

D. Samples: Submit two samples 12 x 12 inches in size illustrating finished aluminum surface, glass, infill panels, 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. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

H. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.

I. Manufacturer's qualification statement.

J. Installer's qualification statement.

1.6 QUALITY ASSURANCE

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

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

1.7 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.

1.8 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.

1.9 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 excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.1 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. YKK AP America, Inc: www.ykkap.com/commercial/#sle.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 BASIS OF DESIGN -- FRAMING FOR INSULATING GLAZING

A. Center-Set Style, Not Thermally-Broken:
   1. Basis of Design: Kawneer Trifab 451.
   2. For interior locations.
   3. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.

B. Front-Set Style, Thermally-Broken:
   1. Basis of Design: Kawneer Tri-fab 451T.
   2. For exterior locations
   3. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.

C. Other Manufacturers: Provide either the product identified as "Basis of Design" or an equivalent product of another manufacturer.

D. Substitutions: See Section 01 60 00 - Product Requirements.
   1. For any product not identified as "Basis of Design", submit information as specified for substitutions.

2.3 BASIS OF DESIGN -- SWINGING DOORS

A. Narrow Stile, Monolithic Glazing:
   1. Basis of Design: Kawneer 190 / 350 / 500.
   2. For interior door locations.
   3. Thickness: 1-3/4 inches.

B. Medium Stile, Insulating Glazing, Thermally-Broken:

1. Basis of Design: Kawneer 190 / 350 / 500.
2. For exterior door locations.
3. Thickness: 1-3/4 inches.

C. Other Manufacturers: Provide either the product identified as "Basis of Design" or an equivalent product of another manufacturer.

D. Substitutions: See Section 01 60 00 - Product Requirements.
1. For any product not identified as "Basis of Design", submit information as specified for substitutions.

2.4 ALUMINUM-FRAMED STOREFRONT

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
1. Finish: Class I color anodized.
a. Factory finish all surfaces that will be exposed in completed assemblies.
2. Finish Color: Black.
3. 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.
4. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
5. 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.
6. 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.
7. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
8. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

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

2.5 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
1. Glazing Stops: Flush.

B. Glazing: See Section 08 80 00.
1. All glazing to be tempered or laminated safety glazing.

C. Swing Doors: Glazed aluminum.
   1. Thickness: 1-3/4 inches.
   2. Glazing Stops: Beveled.
   3. Finish: Same as storefront.

2.6 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Sheet Aluminum: ASTM B209/B209M.

C. Structural Steel Sections: ASTM A36/A36M; galvanized in accordance with requirements of ASTM A123/A123M.

D. Fasteners: Stainless steel.

E. Exposed Flashings: Aluminum sheet, 20 gauge, 0.032 inch minimum thickness; finish to match framing members.

F. Concealed Flashings: Stainless steel, 26 gauge, 0.0187 inch minimum thickness.

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

H. Sealant for Setting Thresholds: Non-curing butyl type.

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

J. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.

2.7 FINISHES

A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils thick.

B. Color: Black.

C. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.8 HARDWARE

A. Confirm required hardware with requirements of Door Hardware Schedule

B. For each exterior door, include weatherstripping, sill sweep strip, and threshold.

C. Other Door Hardware: Storefront manufacturer's standard type to suit application.
   1. Finish on Hand-Contacted Items: To match storefront..
   2. Doors may include butt hinges, pivots, push handle, pull handle, exit device, narrow stile handle latch, and closer.

D. Automatic Door Operators and Actuators: See Section 08 42 29.

PART 3 EXECUTION

3.1 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.

3.2 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. Set thresholds in bed of sealant and secure.

J. Install hardware using templates provided.
   1. See Section 08 42 29 for operator and actuator installation requirements.

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

3.3 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.

3.4 FIELD QUALITY CONTROL

A. Water-Spray Test: Provide water spray quality test of installed storefront components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.
   1. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.

B. Repair or replace storefront components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.5 ADJUSTING

A. Adjust operating hardware and sash for smooth operation.

3.6 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.

3.7 PROTECTION

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

END OF SECTION 08 43 13

SECTION 08 44 13
GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aluminum-framed curtain wall, with vision glazing.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Weld plates embedded in concrete for attachment of anchors.

B. Section 05 12 00 - Structural Steel Framing: Steel attachment members.

C. Section 07 25 00 - Weather Barriers: Sealing framing to water-resistive barrier installed on adjacent construction.

D. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.

E. Section 08 43 13 - Aluminum-Framed Storefronts: Entrance framing and doors.

F. Section 08 80 00 - Glazing.

1.3 REFERENCE STANDARDS

A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.

B. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2015.

C. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.

D. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.

E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

G. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants; 2018 (Reapproved 2022).

H. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

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

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, internal drainage details, and glazing.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.

D. Samples: Submit two samples 6 by 6 inches in size illustrating finished aluminum surface, glazing, infill panels, and 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 and engineering calculations, and identify dimensional limitations; include load calculations at points of attachment to building structure.

G. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.

H. Designer's Qualification Statement.

I. Manufacturer's Qualification Statement.

J. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Designer Qualifications: Design curtain wall and its structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at Ohio.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than three years of documented experience.

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

1.7 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.

1.8 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.

1.9 WARRANTY

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

B. Manufacturer Warranty: Provide 5-year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units. Complete forms in Owner's name and register with installer.

C. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Glazed Aluminum Curtain Walls Manufacturers:
   1. Basis of Design: Kawneer North America; 1600 Wall System 1: www.kawneer.com/#sle.
   2. Oldcastle Building Envelope: www.oldcastlebe.com/#sle.
   3. Tubelite, Inc: www.tubeliteinc.com/#sle.
   4. YKK AP America, Inc: www.ykkap.com/commercial/#sle.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 CURTAIN WALL

A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
   1. Outside glazed, with pressure plate and mullion cover.
   2. Glazing Method: Field glazed system.
   3. Vertical Mullion Face Width: 2-1/2 inches.
   4. Vertical Mullion Depth From Face of Glazing to Back of Frame: 6 inches.
   5. Finish: Class I color anodized.
      a. Factory finish surfaces that will be exposed in completed assemblies.
      b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
   6. Provide flush joints and corners, weathersealed, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
   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.

B. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
   1. Design Wind Loads: Comply with the applicable code.
   2. Movement: Accommodate the following movement without damage to components or deterioration of seals:
      a. Expansion and contraction caused by 180 degrees F surface temperature.
      b. Expansion and contraction caused by cycling temperature range of 170 degrees F over a 12 hour period.

c. Movement of curtain wall relative to perimeter framing.
d. Deflection of structural support framing, under permanent and dynamic loads.

C. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on indoor face when tested as follows:

D. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on indoor face when tested as follows:
1. Test Pressure Differential: 10 psf.

E. Air Leakage: 0.06 cfm/sq ft maximum leakage of wall area when tested in accordance with ASTM E283/E283M at 6.24 psf pressure difference across assembly.

F. Air Leakage: 0.06 cfm/sq ft maximum leakage of wall area when tested in accordance with ASTM E283/E283M at 6.24 psf pressure difference across assembly.

2.3 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.

B. Glazing: See Section 08 80 00.

2.4 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Fasteners: Stainless steel; type as required or recommended by curtain wall manufacturer.

C. Exposed Flashings: Aluminum sheet, 20-gauge, 0.032-inch minimum thickness; finish to match framing members.

D. Concealed Flashings: Galvanized steel, 26-gauge, 0.0179-inch minimum base metal thickness.

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

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

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

H. Glazing Accessories: See Section 08 80 00.

2.5 FINISHES

A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils thick.

B. Color: Black.

PART 3 EXECUTION

3.1 EXAMINATION

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

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

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

3.2 INSTALLATION

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

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

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

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

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

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

G. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

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

3.3 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inch per 3 feet noncumulative or 0.5 inches per 100 feet, whichever is less.

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

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

3.4 FIELD QUALITY CONTROL

A. Provide services of curtain wall manufacturer's field representative to observe for proper installation of system and submit report.

B. Water-Spray Test: Provide water spray quality test of installed curtain wall components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.

C. Repair or replace curtain wall components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.5 CLEANING

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

B. Remove protective material from pre-finished aluminum surfaces.

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

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

3.6 PROTECTION

A. Protect installed products from damage.

END OF SECTION 08 44 13

SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Insulating glass units.

B. Glazing units.

C. Laminated glass interlayers.

D. Glazing compounds.

1.2 RELATED REQUIREMENTS

A. Section 07 92 00 - Joint Sealants: Sealants for other than glazing purposes.

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

C. Section 08 14 16 - Flush Wood Doors: Glazed lites in doors.

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

E. Section 08 44 13 - Glazed Aluminum Curtain Walls: Glazing provided as part of wall assembly.

F. Section 10 28 00 - Toilet, Bath, and Laundry Accessories: Mirrors.

1.3 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 C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

F. ASTM C1036 - Standard Specification for Flat Glass; 2021.

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

H. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass; 2019.

I. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).

J. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.

K. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2016.

L. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.

M. GANA (GM) - GANA Glazing Manual; 2022.

N. GANA (SM) - GANA Sealant Manual; 2008.

O. GANA (LGRM) - Laminated Glazing Reference Manual; 2019.

P. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use; 1990 (2016).

Q. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.

R. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2023.

S. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2023.

1.4 SUBMITTALS

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

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

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

D. Samples: Submit two samples 12 by 12 inch in size of glass units, showing coloration.

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.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with GANA (GM), GANA (SM), GANA (LGRM), and IGMA TM-3000 for glazing installation methods. Maintain one copy on site.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
   1. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.

a. Insulating Glass Certification Council (IGCC).
b. Safety Glazing Certification Council (SGCC).

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

D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.6 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.

1.7 WARRANTY

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

B. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

C. Laminated Glass: Provide a five (5) year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Glass Fabricators:
1. Thompson I.G., LLC: www.thompsonig.com/#sle.
2. Trulite Glass & Aluminum Solutions, LLC: www.trulite.com/#sle.
3. Viracon, Inc: www.viracon.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Float Glass Manufacturers:
1. Cardinal Glass Industries: www.cardinalcorp.com/#sle.
2. Guardian Glass, LLC: www.guardianglass.com/#sle.
3. Pilkington North America Inc: www.pilkington.com/na/#sle.
4. Saint Gobain North America: www.saint-gobain.com/#sle.
5. Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com/#sle.
6. Substitutions: See Section 01 60 00 - Product Requirements.

C. Laminated Glass Manufacturers:
1. Cardinal Glass Industries: www.cardinalcorp.com/#sle.
2. Pilkington North America Inc;: www.pilkington.com/na/#sle.
3. Viracon, Architectural Glass segment of Apogee Enterprises, Inc: www.viracon.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

D. Plastic Films Manufacturers:
1. 3M Window Film: solutions.3m.com/wps/portal/3M/en_US/Window_Film/Solutions/#sle.
2. Flexvue Films: www.flexvuefilms.com/#sle.

3. Llumar, an Eastman Chemical Company: www.llumar.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 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. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.

C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
   1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
   2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
   3. Solar Optical Properties: Comply with NFRC 300 test method.

2.3 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 HS - Heat-Strengthened Type: Complies with ASTM C1048.
   3. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
   4. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
   5. Thicknesses: As indicated; provide greater thickness as required for exterior glazing wind load design.

B. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
   1. Laminated Safety Glass: Complies with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.
   2. Polyvinyl Butyral (PVB) Interlayer: 0.030 inch thick, minimum.

2.4 INSULATING GLASS UNITS

A. Manufacturers:
   1. Glass: Any of the manufacturers specified for float glass.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Fabricator: Certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.

C. Insulating Glass Units: Types as indicated.
   1. Durability: Certified by an independent testing agency to comply with ASTM E2190.

2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
3. Warm-Edge Spacers: Low-conductivity thermoplastic with desiccant warm-edge technology design.
   a. Spacer Width: As required for specified insulating glass unit.
   b. Spacer Height: Manufacturer's standard.
   c. Products:
      1) H.B. Fuller Construction Products Inc; Kodispace 4SG: www.hbfuller.com/#sle.
      2) Quanex IG Systems, Inc; Super Spacer TriSeal: www.quanex.com/#sle.
      3) Technoform Glass Insulation; TGI-Spacer: www.glassinsulation.us/#sle.
      4) Substitutions: See Section 01 60 00 - Product Requirements.
4. Spacer Color: Black.
5. Edge Seal:
   a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone, polysulfide, or polyurethane sealant as secondary seal applied around perimeter.
   b. Color: Black.
6. Purge interpane space with dry air, hermetically sealed.

D. Type IG-1 - Insulating Glass Units: Vision glass, double glazed.
1. Applications: Exterior glazing unless otherwise indicated.
2. Space between lites filled with air.
3. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
   a. Tint: Blue.
   b. Coating: Low-E (passive type), on #2 surface.
4. Warm-edge spacer.
5. Inboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
   a. Tint: Clear.
6. Total Thickness: 1 inch.
7. Thermal Transmittance (U-Value), Summer - Center of Glass: _____, nominal.
8. Visible Light Transmittance (VLT): _____ percent, nominal.
9. Solar Heat Gain Coefficient (SHGC): _____, nominal.
10. Glazing Method: Dry glazing method, gasket glazing.

E. Type IG-2 - Insulating Glass Units: Spandrel glazing.
1. Applications: Exterior spandrel glazing unless otherwise indicated.
2. Space between lites filled with air.
3. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
   a. Tint: Clear.
   b. Coating: Same as on vision units, on #2 surface.
4. Warm-edge spacer.
5. Inboard Lite: Heat-strengthened float glass, 1/4 inch thick.
   a. Tint: Clear.
   b. Opacifier: Elastomeric coating, on #4 surface.
      1) Opacifier Color: Black.
6. Total Thickness: 1 inch.
7. Thermal Transmittance (U-Value), Summer - Center of Glass: _____, nominal.
8. Glazing Method: Dry glazing method, gasket glazing.

2.5 GLAZING UNITS

A. Type G-1 - 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: Laminated safety safety glass as specified.
   3. Tint: Clear.
   4. Thickness: 1/4 inch, nominal.
   5. Glazing Method: Dry glazing method, gasket glazing.

2.6 LAMINATED GLASS INTERLAYERS

A. Polyvinyl Butyral (PVB) Interlayer for Laminated Glazing:
   1. Functionality: Post-breakage safety and security.
   2. Applications:
      a. Single pane, laminated glass unit.
   3. Color: Clear.
   4. Thickness: As required for indicated performance of laminated glass application.
   5. Manufacturers:
      a. Eastman Chemical Company; Saflex Clear PVB Interlayer: www.saflex.com/#sle.
      b. Sekisui S-LEC America, LLC; S-LEC Clear Film: www.s-lec.us/#sle.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

2.7 GLAZING COMPOUNDS

A. Type GC-1 - Glazing Putty: Polymer modified latex, knife grade consistency; gray color.

B. Type GC-2 - Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.

2.8 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. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Continuous by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.

C. 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.
   1. Width: As required for application.
   2. Thickness: As required for application.
   3. Spacer Rod Diameter: As required for application.

D. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

E. Glazing Clips: Manufacturer's standard type.

PART 3 EXECUTION

3.1 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 the minimum required face and edge clearances are being provided.

C. 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.

D. Verify that sealing between joints of glass framing members has been completed effectively.

E. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.2 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.

3.3 INSTALLATION, GENERAL

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

B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.

C. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.

D. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.

E. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.

F. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, and paint.

3.4 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.

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

A. Application - Interior Glazed: Set glazing infills from the interior of the building.

B. Cut glazing tape to length and install against permanent stops, projecting 1/16 inch above sight line.

C. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.

D. Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.

E. Install removable stops, spacer shims inserted between glazing and applied stops at 24 inch intervals, 1/4 inch below sight line.

F. Fill gaps between pane and applied stop with sealant to depth equal to bite on glazing, to uniform and level line.

G. Carefully trim protruding tape with knife.

3.6 INSTALLATION - PLASTIC FILM

A. Install plastic film with adhesive, applied in accordance with film manufacturer's instructions.

B. Place without air bubbles, creases or visible distortion.

C. Install film tight to perimeter of glass and carefully trim film with razor sharp knife. Provide 1/16 inch to 1/8 inch gap at perimeter of glazed panel unless otherwise required. Do not score the glass.

3.7 FIELD QUALITY CONTROL

A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.

B. Monitor and report installation procedures and unacceptable conditions.

3.8 CLEANING

A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

B. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.

C. Remove nonpermanent labels immediately after glazing installation is complete.

D. Clean glass and adjacent surfaces after sealants are fully cured.

E. 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.

3.9 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

1.1 SECTION INCLUDES

A. Glazing film applied to glazing assemblies.

B. Glazing assemblies to receive film are indicated on drawings.

1.2 RELATED REQUIREMENTS

A. Section 08 80 00 - Glazing: New glazing to received film.

1.3 REFERENCE STANDARDS

1.4 SUBMITTALS

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

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Record of product certification for safety requirements.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods.

C. Shop Drawings: Detailing installation of film, anchoring accessories, and sealant.

D. Samples: For each film product to be used, minimum size 4 inches by 6 inches, representing actual product, color, and patterns.

E. Specimen Warranty.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Glazing film manufacturer specializing in manufacture of safety glazing films with minimum 10 years successful experience.

B. Installer Qualifications: Certified by glazing film manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under

environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

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

B. Provide 10 year manufacturer's replacement warranty to cover film against peeling, cracking, discoloration, and deterioration.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basic of Design: MDC pressure sensitive adhesive-backed film: www.mdcwall.com

B. Flexvue Films: www.flexvuefilms.com/#sle.

C. Madico, Inc: www.madico.com/#sle.

D. Substitutions: See section 01 25 00 for Substitution Procedures.

2.2 MATERIALS

A. Glazing Film: PVC free film for permanent bonding to glass..
   1. Thickness: 2 mil.
   2. Design and Colors: Custom digital design vector provided by Architect.
   3. Adhesive Type: Pressure-activated adhesive.

B. Accessory Materials: As recommended or required by film manufacturer.

C. Glass Cleaner: As recommended by glazing film manufacturer.

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 INSTALLATION

A. Do not apply glazing film when surface temperature is less that 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. Supplemental Anchors: Install in accordance with manufacturer's instructions and shop drawings.

F. Clean glass and anchoring accessories following installation. Remove excess sealants and other glazing materials from adjacent finished surfaces.

G. Remove labels and protective covers.

3.4 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 08 87 23

SECTION 09 05 61
COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
   1. Resilient tile and sheet.
   2. Broadloom carpet.
   3. Carpet tile.
   4. Thin-set ceramic tile and stone tile.

B. Preparation of new concrete floor slabs for installation of floor coverings.

C. Testing of concrete floor slabs for moisture and alkalinity (pH).

D. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
   1. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under Contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.

E. Patching compound.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Limitations on curing requirements for new concrete floor slabs.

1.3 REFERENCE STANDARDS

A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens); 2021.

B. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete; 2020.

C. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.

D. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

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

B. 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.

C. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.
   1. Manufacturer's qualification statement.
   2. Certificate: Manufacturer's certification of compatibility with types of flooring applied over remedial product.
   3. Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.
   4. Manufacturer's installation instructions.
   5. Specimen Warranty: Copy of warranty to be issued by coating manufacturer and certificate of underwriter's coverage of warranty.

D. Testing Agency's Report:
   1. Description of areas tested; include floor plans and photographs if helpful.
   2. Summary of conditions encountered.
   3. Moisture and alkalinity (pH) test reports.
   4. Copies of specified test methods.
   5. Recommendations for remediation of unsatisfactory surfaces.
   6. Submit report to Architect.
   7. Submit report not more than two business days after conclusion of testing.

E. Adhesive Bond and Compatibility Test Report.

F. Floor Moisture Testing Technician Certificate: International Concrete Repair Institute (ICRI) Concrete Slab Moisture Testing Technician- Grade I certificate.

1.6 QUALITY ASSURANCE

A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.

B. 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.

C. Contractor's Responsibility Relating to Independent Agency Testing:
   1. Provide access for and cooperate with testing agency.
   2. Confirm date of start of testing at least 10 days prior to actual start.
   3. Allow at least 4 business days on site for testing agency activities.
   4. Achieve and maintain specified ambient conditions.
   5. Notify Architect when specified ambient conditions have been achieved and when testing will start.

D. Floor Moisture Testing Technician Qualifications: International Concrete Repair Institute (ICRI) Concrete Slab Moisture Testing Technician Certification- Grade I.

E. Remedial Coating Installer Qualifications: Company specializing in performing work of the type specified in this section, trained by or employed by coating manufacturer, and able to provide at least 3 project references showing at least 3 years' experience installing moisture emission coatings.

1.7 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.

1.8 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

2.1 MATERIALS

A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
   1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
   2. Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.
   3. Products:
      a. ARDEX Engineered Cements; ARDEX Feather Finish: www.ardexamericas.com/#sle.
      b. H.B. Fuller Construction Products, Inc; TEC Feather Edge Skim Coat: www.tecspecialty.com/#sle.
      c. LATICRETE International, Inc; SKIM LITE: www.laticrete.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 CONCRETE SLAB PREPARATION

A. Follow recommendations of testing agency.

B. Perform following operations in the order indicated:
   1. Preliminary cleaning.
   2. 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.
   3. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
   4. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
   5. Specified remediation, if required.
   6. Patching, smoothing, and leveling, as required.
   7. Other preparation specified.
   8. Adhesive bond and compatibility test.
   9. Protection.

3.2 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.

3.3 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.

3.4 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.

3.5 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. 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.

3.6 PREPARATION

A. See individual floor covering section(s) for additional requirements.

B. Comply with requirements and recommendations of floor covering manufacturer.

C. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.

D. Do not fill expansion joints, isolation joints, or other moving joints.

3.7 ADHESIVE BOND AND COMPATIBILITY TESTING

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

3.8 APPLICATION OF REMEDIAL FLOOR COATING

A. Comply with requirements and recommendations of coating manufacturer.

END OF SECTION 09 05 61

SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.

B. Metal stud wall framing.

C. Metal channel ceiling framing.

D. Acoustic insulation.

E. Gypsum wallboard.

F. Joint treatment and accessories.

1.2 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 05 40 00 - Cold-Formed Metal Framing: Structural steel stud framing.

C. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

D. Section 07 21 00 - Thermal Insulation: Non-acoustic insulation.

E. Section 07 25 00 - Weather Barriers: Water-resistive barrier over sheathing.

F. Section 07 84 00 - Firestopping: Top-of-wall assemblies at fire-resistance-rated walls.

G. Section 07 92 00 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

1.3 REFERENCE STANDARDS

A. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data; 2017.

B. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.

C. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015, with Errata (2020).

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

E. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.

F. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.

G. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).

H. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board; 2004 (Reapproved 2020).

I. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.

J. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.

K. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2023.

L. 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.

M. 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.

N. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.

O. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2018.

P. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.

Q. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.

R. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

S. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).

T. ASTM E413 - Classification for Rating Sound Insulation; 2022.

U. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.

1.4 ADMINISTRATIVE REQUIREMENTS

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

B. Sequencing: Install service utilities in an orderly and expeditious manner.

1.5 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.

2. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

C. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.

D. Steel Framing Industry Association (SFIA) Certification:
1. Submit documentation that metal studs and connectors used on project meet or exceed requirements of International Building Code.
2. Submit current documentation of contractor and fabricator accreditation. Keep copies of each on-site during and after installation, and present upon request.

E. Test Reports: For stud framing products that do not comply with AISI S220 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.

F. Installer's Qualification Statement.

1.6 QUALITY ASSURANCE

A. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in Ohio.

B. SFIA Code Compliance Certification Program: www.CFSteel.org/#sle: Use metal studs and connectors certified for compliance with International Building Code.

C. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.

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

E. Documents at Project Site: Maintain at the project site a copy of manufacturer's instructions, erection drawings, and shop drawings.

1.7 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

2.1 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.
1. See PART 3 for finishing requirements.

B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:

1. Acoustic Attenuation: STC of 55-59 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.2 METAL FRAMING MATERIALS

A. Material and Product Requirements Criteria: AISI S201.

B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
   1. Structural Grade: As required to meet design criteria.
   2. Corrosion Protection Coating Designation: G40, or equivalent in accordance with AISI S220.

C. Manufacturers - Metal Framing, Connectors, and Accessories:
   1. ClarkDietrich: www.clarkdietrich.com/#sle.
   2. MarinoWARE: www.marinoware.com/#sle.
   3. Substitutions: See Section 01 60 00 - Product Requirements.

D. 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. Minimum stud requirements: 20 gauge, 3 5/8", 16" O.C.
   3. Runners: U shaped, sized to match studs.
   4. Ceiling Channels: C-shaped.
   5. Flexible Track: Flexible framing consisting of adjustable leg straps and pivoting, hinged track brackets designed to provide curved framing assemblies of varying radii.

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. Non-structural Framing Accessories:
   1. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
      a. Materials: ASTM A36/A36M formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.

2.3 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
   1. American Gypsum Company: www.americangypsum.com/#sle.
   2. CertainTeed Corporation: www.certainteed.com/#sle.
   3. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
   4. Gold Bond Building Products, LLC provided by National Gypsum Company: www.goldbondbuilding.com/#sle.
   5. USG Corporation: www.usg.com/#sle.
   6. 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, unless otherwise indicated.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.

a. Mold-resistant board is required whenever board is being installed before the building is enclosed and conditioned.

3. Thickness:
   a. Vertical Surfaces: 5/8 inch.
   b. Ceilings / Soffits: 5/8 inch.
   c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.

C. Backing Board For Wet Areas:
   1. Application: Surfaces behind tile in wet areas.
   2. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
      a. Regular Type: Thickness 1/2 inch.

2.4 GYPSUM BOARD ACCESSORIES

A. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness as required for STC.

B. Sound Isolation Tape: Elastomeric foam tape for sound decoupling.
   1. Surface Burning Characteristics: Provide assemblies with flame spread index of 75 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
   2. Tape Thickness: 1/4 inch.

C. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

D. 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.

E. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
   1. Fiberglass Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
   2. Joint Compound: Setting type, field-mixed.

F. Finishing Compound: Surface coat and primer, takes the place of skim coating.

G. 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.

H. 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.

I. Nails for Attachment to Wood Members: ASTM C514.

J. Staples For Attachment of Base Ply of Two-Ply Assembly to Wood Members: Flattened galvanized wire type as specified in ASTM C840.

K. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C1007AISI S220 and manufacturer's instructions.

B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
   1. Level ceiling system to a tolerance of 1/1200.
   2. Laterally brace entire suspension system.
   3. Install bracing as required at exterior locations to resist wind uplift.

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 with miniimum 16 ga, studs as required for weight of doors or operable panels, using not less than double studs at head and jambs.

3.3 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Sound Isolation Tape: Apply to vertical studs and top and bottom tracks/runners in accordance with manufacturer's instructions.

C. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.4 BOARD INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
   1. Exception: Tapered edges to receive joint treatment at right angles to framing.

C. Double-Layer, Nonrated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.

D. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.

E. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.

3.5 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.

3.6 JOINT TREATMENT

A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.

B. 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 3: Walls to receive textured wall finish.
   4. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
   5. Level 1: Wall areas above finished ceilings, whether or not accessible in the completed construction.
   6. Level 0: Temporary partitions.
   7. Level 0: Surfaces indicated to be finished in later stage of project.

C. 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.
   2. Taping, filling, and sanding are not required at base layer of double-layer applications.

D. 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.

3.7 TOLERANCES

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

3.8 CLEANING

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

3.9 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

1.1 SECTION INCLUDES

A. Tile for floor applications.

B. Ceramic accessories.

C. Non-ceramic trim.

1.2 RELATED REQUIREMENTS

A. Section 03 54 00 - Cast Underlayment.

B. Section 07 92 00 - Joint Sealants: Sealing joints between tile work and adjacent construction and fixtures.

C. Section 09 21 16 - Gypsum Board Assemblies: Tile backer board.

1.3 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 A118.7 - American National Standard Specifications for High Performance Cement Grouts for Tile Installation; 2019.

R. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 2019.

S. ANSI A118.15 - American National Standard Specifications for Improved Modified Dry-Set Cement Mortar; 2019.

T. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2022.

U. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2023.

V. TCNA (HB-GP) - Handbook for Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs Installation; 2023.

1.4 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. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.

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

E. Installer's Qualification Statement:
   1. Submit documentation of National Tile Contractors Association (NTCA) or Tile Contractors' Association of America (TCAA) accreditation.

F. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Tile: 1 percent of each size, color, and surface finish combination, but not less than 1 box of each type.

1.5 QUALITY ASSURANCE

A. Maintain one copy of ANSI A108/A118/A136, TCNA (HB), and TCNA (HB-GP) on-site.

B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.

C. Installer Qualifications:
   1. Company specializing in performing tile installation, with minimum of five years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 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.

PART 2 PRODUCTS

2.1 TILE

A. Manufacturers: All products by the same manufacturer.
   1. American Olean Corporation; _____: www.americanolean.com/#sle.
   2. Dal-Tile Corporation; _____: www.daltile.com/#sle.
   3. Basis of Design: Del Conca: https://www.delconcausa.com
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Porcelain Tile, Type T-01: ANSI A137.1 standard grade.
   1. Size: 8 by 8 inch, nominal
   2. Finish: Glazed
   3. Thickness: 8.5 mm
   4. DCOF: ≥0.42
   5. Color: Fragrance - Bianco
   6. Pattern: Vertically stacked
   7. Trim Units: Matching bullnose, cove base, and cove shapes in sizes coordinated with field tile.

2.2 TRIM AND ACCESSORIES

A. Non-Ceramic Trim: Brushed stainless steel, style and dimensions to suit application, for setting using tile mortar or adhesive.
   1. Applications:
      a. Open edges of wall and floor tile.
      b. Transition between floor finishes of different heights.
      c. Borders and other trim as indicated on drawings.
   2. Products:
      a. Basis of Design: Schluter-Systems: www.schluter.com/#sle.
      b. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 SETTING MATERIALS

A. Provide setting and grout materials from same manufacturer.

B. Manufacturers:
   1. ARDEX Engineered Cements: www.ardexamericas.com/#sle.
   2. Custom Building Products: www.custombuildingproducts.com/#sle.
   3. H.B. Fuller Construction Products, Inc: www.tecspecialty.com/#sle.
   4. LATICRETE International, Inc: www.laticrete.com/#sle.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

C. Improved Latex-Portland Cement Mortar Bond Coat: ANSI A118.15.
   1. Applications: Use this type of bond coat where Large and Heavy Tile (LHT) mortar is indicated.
   2. Products:
      a. ARDEX Engineered Cements; S 28: www.ardexamericas.com/#sle.
      b. Custom Building Products; Complete Contact-LFT Premium Rapid Setting Large Format Tile Mortar, with Multi-Surface Bonding Primer: www.custombuildingproducts.com/#sle.
      c. H.B. Fuller Construction Products, Inc; TEC TotalFlex 150 Universal Mortar: www.tecspecialty.com/#sle.
      d. LATICRETE International, Inc; MULTIMAX LITE: www.laticrete.com/#sle.
      e. Substitutions: See Section 01 60 00 - Product Requirements.

2.4 GROUTS

A. Provide setting and grout materials from same manufacturer.

B. High Performance Polymer Modified Grout: ANSI A118.7 polymer modified cement grout.
   1. Applications: Use this type of grout where indicated and where no other type of grout is indicated.
   2. Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.
   3. Color(s): Dusty Grey - 90 - Laticrete: Basis of Design
   4. Products:
      a. ARDEX Engineered Cements: www.ardexamericas.com/#sle.
      b. Custom Building Products: www.custombuildingproducts.com/#sle.
      c. H.B. Fuller Construction Products, Inc: www.tecspecialty.com/#sle.
      d. Basis of Design: LATICRETE International, Inc; LATICRETE PERMACOLOR Grout: www.laticrete.com/#sle.
      e. Substitutions: See Section 01 60 00 - Product Requirements.

2.5 MAINTENANCE MATERIALS

A. Tile Sealant: Gunnable, silicone, siliconized acrylic, or urethane sealant; moisture and mildew resistant type.
   1. Applications: Between tile and plumbing fixtures.
   2. Color(s): As selected by Architect from manufacturer's full line.

B. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
   1. Composition: Water-based colorless silicone.
   2. Products:
      a. STONETECH, a Division of LATICRETE International, Inc; STONETECH Heavy Duty Grout Sealer: www.laticrete.com/#sle.
      b. Merkrete, by Parex USA, Inc; Merkrete Revive: www.merkrete.com/#sle.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 ACCESSORY MATERIALS

A. Backer Board: Cementitious type complying with ANSI A118.9; high density, glass fiber reinforced, 7/16 inch thick; 2 inch wide coated glass fiber tape for joints and corners.

PART 3 EXECUTION

3.1 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 required floor-mounted utilities are in correct location.

3.2 PREPARATION

A. Protect surrounding work from damage.

B. Vacuum clean surfaces and damp clean.

C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

D. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.

E. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.3 INSTALLATION - GENERAL

A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) 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 with trim piece.

F. Install non-ceramic trim in accordance with manufacturer's instructions.

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. Use standard grout 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.

3.4 INSTALLATION - WALL TILE

A. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.

3.5 CLEANING

A. Clean tile and grout surfaces.

3.6 PROTECTION

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

END OF SECTION 09 30 00

SECTION 09 51 10
ACOUSTICAL TILE CEILINGS

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 acoustical tile ceiling panels and exposed suspension systems for ceilings.
   1. Acoustical ceiling panels,
   2. Ceiling suspension systems,

1.3 SUBMITTALS

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

B. Samples for Initial Selection: For components with factory-applied color finishes.

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

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.7 EXTRA MATERIALS

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

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

PART 2 PRODUCTS

2.1 ACOUSTICAL PANELS, GENERAL

A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
   1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

C. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.2 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING (ACT-01)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong World Industries, Inc.
   2. CertainTeed; SAINT-GOBAIN.
   3. USG Corporation.
   4. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

B. Basis-of-Design Product “ACT-01”: Subject to compliance with requirements, provide the product indicated or a comparable product approved by Architect prior to bid:
   1. Basis of Design – Armstrong World Industries, Ultima Square Layin 1910HRC (High Recycled Content)
      a. Classification: Provide panels complying with ASTM E1264 and type, form, pattern as follows:
         1) Type: IV
         2) Form: 2
         3) Pattern: E
      b. Color: White.
      c. Panel Size: 24 inch x 24 inch
      d. Thickness: 3/4 in
      e. Edge: Square Tegular 15/16
      f. Acoustics: 0.75 NRC
         1) Materials: Mineral Fiber
      g. Texture: Fine

h. Sound Absorption (NRC): Up to 1.00
i. Sound Blocking (CAC): 35 min.
j. Articulation Class (AC) Up to 190
k. Fire Performance: Class A (UL)
l. Light Reflectance: 88%
m. Mold/Mildew Resistance: BIOBLOCK Inherent
n. Sag/Humidity Resistance: Sag/Humidity Resistance
o. Durability: Soil Resistance, Impact Resistance, Scratch Resistance, Washability
p. Disinfectability: Fog

C. Basis-of-Design Product "ACT-02": Subject to compliance with requirements, provide the product indicated or a comparable product approved by Architect prior to bid:
1. Basis of Design – Armstrong World Industries, Ultima Health Zone 1445
a. Classification: Provide panels complying with ASTM E1264 and type, form, pattern as follows:
1) Type: IV
2) Form: 2
3) Pattern: E
b. Color: White.
c. Panel Size: 24 inch x 24 inch
d. Thickness: 3/4 in
e. Edge: Square 15/16
f. Acoustics: 0.80 NRC
1) Materials: Mineral Fiber
g. Texture: Fine
h. Sound Absorption (NRC): Up to 1.00
i. Sound Blocking (CAC): 35 min.
j. Articulation Class (AC) Up to 190
k. Fire Performance: Class A (UL)
l. Light Reflectance: 86%
m. Mold/Mildew Resistance: BIOBLOCK Inherent
n. Sag/Humidity Resistance: Sag/Humidity Resistance
o. Durability: Soil Resistance, Impact Resistance, Scratch Resistance, Washability
p. Disinfectability: Fog

2.3 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C635.

B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

C. Attachment Devices: Size for five times the design load indicated in ASTM C635, Table 1, "Direct Hung," unless otherwise indicated.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A641, Class 1 zinc coating, soft temper.
2. Stainless-Steel Wire: ASTM A580, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.

4. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch-diameter wire.

E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized steel sheet complying with ASTM A653, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.

F. Hold-Down Clips (Vestibules): Provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees at Vestibules and within 6' of any exterior door. .

METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

G. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:
   1. Basis of Design – Armstrong World Industries.
      a. Prelude Series.
   2. Chicago Metallic Corporation.
   3. USG.

H. Wide-Face, Capped, Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, with prefinished 15/16-inch-wide metal caps on flanges.
   1. Exposed Tee System.
   2. Face Design: Flat, flush.
   3. Cap Material: Steel cold-rolled sheet.
   4. Cap Finish: Painted to match color of acoustical unit.
   5. Painting: Hot-dipped galvanized coating.
   6. Color: White.

2.4 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with the requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
   1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
   2. At ceiling “clouds” where exposed edge of ceiling tiles do not terminate at a wall, provide 6" high extruded metal edge trim. No cut edges of tile will be exposed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

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

3.2 PREPARATION

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

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C636, and per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

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

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
   1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.

2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
   1. Arrange directionally patterned acoustical panels as follows:
      a. Install panels with pattern running in one direction parallel to long axis of space.
   2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
   3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
   4. Install hold-down clips in areas indicated, as recommended by panel manufacturer's written instructions, unless otherwise indicated.
   5. Install impact clips in areas indicated, as recommended by panel manufacturer's written instructions, unless otherwise indicated.

G. Owner's attic stock: Provide one (1) case of ceiling pads of each type and product used for Owner's attic stock.

3.4 CLEANING

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

END OF SECTION 09 51 10 09 51 10

SECTION 09 51 26
SUSPENDED WOOD VENEER CEILING

PART 1 - GENERAL

1.1 SECTIONS INCLUDE

1.2 WOODWORKS LINEAR VENEERED PANELS

1.3 EXPOSED GRID SUSPENSION SYSTEM.

1.4 WIRE HANGERS, FASTENERS, MAIN RUNNERS, CROSS TEES, WALL ANGLE MOLDINGS AND ACCESSORIES.

1.5 RELATED REQUIREMNTS:

A. Section 09 51 10 - Acoustical Ceiling Suspension Assembly

B. Section 09 21 16 - Plaster and Gypsum Board

C. Section 09 22 16 - Non-Structural Metal Framing

D. Divisions 23 (15) - HVAC

E. Division 26 (16) Sections - Electrical Work

1.6 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   2. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
   3. ASTM A 1008 Standard Specification for Steel, Sheet, and Cold Rolled Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   4. ASTM C 635 Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
   5. ASTM C 636 Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
   6. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.
   7. ASTM E 580 Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Seismic Restraint.
   8. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
   9. ASTM E 1264 Classification for Acoustical Ceiling Products.
   10. Hardwood Plywood & Veneer Association (HPVA)
   11. International Building Code
   12. ASHRAE Standard 62 1 2004 Ventilation for Acceptable Indoor Air Quality
   13. NFPA 70 National Electrical Code

14. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures
15. International Code Council-Evaluation Services - AC 156 Acceptance Criteria for Seismic Qualification Testing of Non-structural Components
16. International Code Council-Evaluation Services Report - Seismic Engineer Report
    a. ESR 1308 - Armstrong T-Bar or Dimensional Suspension
17. California Air Resources Board (CARB) compliant
18. LEED - Leadership in Energy and Environmental Design is a set of rating systems for the design, construction, operation, and maintenance of green buildings

1.7 SUBMITTALS

A. See section 01 30 00 - Administrative Requirements for Submittal Procedures.

B. Shop Drawings: Layout and details of ceilings. Show locations of items that are to be coordinated with or supported by the ceilings.

C. Installation Instructions: Submit manufacturer's installation instructions as referenced in Part three, Installation.

D. Product Data: Submit manufacturer's technical data for each type of ceiling unit and suspension system required.

E. Samples: Real Wood Veneer on fire rated particle board – Semi-gloss tinted topcoat – Clear Finish

F. Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards.

G. Non-Conformance: All products not conforming to the requirements of this specification and or the manufacturer's published values are to be disposed. The Contractor performing the work will replace with approved product at their expense.

1.8 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide ceiling panel units and grid components by a single manufacturer.

B. Fire Performance Characteristics: Identify ceiling components with appropriate markings of applicable testing and inspecting organization.
   1. Surface Burning Characteristics: As follows, tested per ASTM E-84 and complying with ASTM E 1264 for Class A products.
   2. HPVA (Hardwood Plywood and Veneer Association) certification and audit program per ASTM E-84 tunnel test.

C. Woodworking Standards: Manufacturer must comply with specified provisions of Architectural Woodworking Institute quality standards.

D. Coordination of Work: Coordinate ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store ceiling components in a dry interior location in their cartons prior to installation to avoid damage. Store cartons in a flat, horizontal position. The protectors between the panels should not be removed until installation.

B. Do not store in unconditioned spaces with humidity greater than 55 percent or lower than 25 percent relative humidity and temperatures lower than 50 degrees F or greater than 86 degrees F. Panels must not be exposed to extreme temperatures, for example, close to a heating source or near a window with direct sunlight.

C. Handle ceiling units carefully to avoid chipped edges or damage to units in any way.

1.10 PROJECT CONDITIONS

A. Wood ceiling materials should be permitted to reach room temperature and have a stabilized moisture content for a minimum of 72 hours before installation. (Remove plastic wrap to allow panels to climatize).

B. The wood panels should not be installed in spaces where the temperature or humidity conditions vary from the temperatures and conditions that will be normal in the occupied space.

C. As interior finish products, the veneered panels are designed for installation in temperature conditions between 50 degrees F and 86 degrees F, in spaces where the building is enclosed, and HVAC systems are functioning and will be in continuous operation. Relative humidity should not fall below 25 percent or exceed 55 percent.

1.11 WARRANTY

A. Veneered Wood Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to:
   1. Veneered Wood Panels: Defects in materials or factory workmanship.
   2. Grid System: Rusting and manufacturing defects.

B. Warranty Period:
   1. Veneered Wood panels: One (1) year from date of installation.
   2. Grid: Ten years from date of installation.

C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.12 9 MAINTENANCE

A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.
   1. Ceiling Units: Furnish quality of full-size units equal to 2.0 percent of amount installed.
   2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 1.0 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design WoodWorks Linear Veneered Panels:
   1. Armstrong World Industries, Inc.

B. Suspension Systems:
   1. Armstrong World Industries, Inc.

2.2 WOOD CEILING UNITS

A. Ceiling Panels Type (CLNG B)
   1. Surface Texture: Smooth
   2. Composition: Real wood veneer on fire rated particle board
   3. Finish(s): Real Wood Veneer
      a. Plain Slice White Oak (NOK)
   4. Plank Width:
      a. 4" Plank Modules (Nominal) Width: 4.05-inch (Actual)
   5. Panel Width:
      a. 4" Plank Module Panel Width: 24-inch (Nominal): 23-1/4-inch (Actual)
   6. Panel Length Size(s):
      a. 4" Plank Module Panel Length: 96-inch (Nominal): 95-1/4-inch (Actual) - With 3/4" reveal panel to panel @ length & Width
   7. WoodWorks Linear Veneered Panel Options:
      a. Height – Number of Planks (Plank Width) – Reveal Width [item#]
         1) 3/4" – 4 Planks (5.75") – 1/4" [6691F01W1 _ NOK]
   8. Acoustical Performance Infill Options:
      a. Calla Square Lay-in panel - Item 2820BK
      b. Fiberglass Infill Panel – Item 8200T10
   9. Flame Spread:
      a. Class A: ASTM E84 surface burning characteristics. Flame Spread Index 25 or less. Smoke Developed Index 50 or less.

B. Accessories:
   1. Backer Clip - Item 5687
   2. Tee Bar Hook – Item 5986
   3. Wood Screws – Item 7123PKG300
   4. Safety Cable – Item 6091
   5. Support Hanger – Item SH12
   6. Beam End Retaining Clip – Item BERC2

2.3 SUSPENSION SYSTEMS

A. Components: All main beams and cross tees shall be commercial quality hot dipped galvanized steel as per ASTM A653. Main beams and cross tees are double-web steel construction with 15/16-inch type exposed flange design. Exposed surfaces chemically cleansed, capping prefinished galvanized steel in baked polyester paint. Main beams and cross tees shall have rotary stitching.
   1. Structural Classification: ASTM C635 (Heavy Duty)
   2. Color: Tech Black.

3. Acceptable Product: Prelude XL 15/16" 12' HD Main beam item 7301BL, Prelude XL 2' Cross Tee XL8320BL as manufactured by Armstrong World Industries, Inc.
4. 12-Gauge Hanger Wire – Item 7891

B. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

C. Wire for Hangers and Ties: ASTM A641, Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least times-three design load, but not less than 12 gauge.

D. Accessories/Edge Moldings and Perimeter Trim:
1. 7/8" Angle Wall Molding - item7800BL
2. 6" Veneered Trim with 4 Clips – item 6481F07W1H6---(Finish Suffix available: NWM, NWA, NOK, NPC, NWN, NVF, NRO, NQW, NQS, NWM) - W/Faux Wood Edgebanding
3. 8" Veneered Trim with 4 Clips – item 6481F07W1H8---(Finish Suffix available: NWM, NWA, NOK, NPC, NWN, NVF, NRO, NQW, NQS, NWM) - W/Real Wood Edgebanding
4. 6" Veneered Trim with 4 Clips – item 6481F01W1H6---(Finish Suffix available: NMP, NLC, CWA, CRW) - W/Faux Wood Edgebanding
5. 8" Veneered Trim with 4 Clips – item 6481F01W1H8---(Finish Suffix available: NMP, NLC, CWA, CRW) - W/Faux Wood Edgebanding
6. Replacement Trim Clip – item 5925
7. Adjustable Trim Clip – item 7239
8. Axiom Vector Straight Trim - Recommend in Black 6" and up – AX_VESTR_ _ (Finish Suffix Recommended: BL, SG, MY)
9. Axiom Vector Curved Trim - Recommend in Black 6" and up – AX_VECUR_ _ (Finish Suffix Recommended: BL, SG, MY)
10. WoodWorks Edgebanding (Coordinating Faux Wood) – item 6408_ _ _ (Finish Suffix available: All)
11. WoodWorks Edgebanding (Coordinating Real Wood) – item 6408D5_ _ _ (Finish Suffix available: NWM, NWA, NOK, NPC, NWN, NVF, NRO, NQW, NQS, NWM)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out.

B. Proper designs for both supply air and return air, maintenance of the HVAC filters and building interior space are essential to minimize soiling. Before starting the HVAC system, make sure supply air is properly filtered and the building interior is free of construction dust.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.

B. WoodWorks ceiling materials should be permitted to reach room temperature and have a stabilized moisture content for a minimum of 72 hours before installation. (Remove plastic wrap to allow panels to climatize).

3.3 INSTALLATION

A. Interior WoodWorks products, the veneered wood panels are designed for installation in temperature conditions between 50 degrees F and 86 degrees F, in spaces where the building is enclosed, and HVAC systems are functioning and will be in continuous operation. Relative humidity should not fall below 25 percent or exceed 55 percent.

B. Install suspension system and panels in compliance with ASTM C636, ASTM E580, with the approval of the authorities having jurisdiction, and in accordance with the manufacturer's WoodWorks Linear Veneered Panels Installation Instructions.

3.4 ADJUSTING AND CLEANING

A. Replace damaged and broken panels.

B. Clean exposed surfaces of ceilings panels, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage.

END OF SECTION 09 51 26

SECTION 09 65 00
RESILIENT FLOORING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Resilient sheet flooring.

B. Resilient tile flooring.

C. Resilient base.

D. Installation accessories.

1.2 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 03 30 00 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors to receive adhesive-applied resilient flooring.

C. Section 09 05 61 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.

D. Section 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

E. Section 09 65 13 - Resilient Base and Accessories

F. Section 09 65 19 - Resilient Tile Flooring

1.3 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 E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).

C. ASTM E492 - Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine; 2022.

D. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2023.

E. ASTM E2179 - Standard Test Method for Laboratory Measurement of the Effectiveness of Floor Coverings in Reducing Impact Sound Transmission Through Concrete Floors; 2021.

F. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.

G. ASTM F1344 - Standard Specification for Rubber Floor Tile; 2021a.

H. ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile; 2020.

I. ASTM F1859 - Standard Specification for Rubber Sheet Floor Covering Without Backing; 2021a.

J. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021.

K. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.

L. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

M. NSF 332 - Sustainability Assessment for Resilient Floor Coverings; 2022.

N. UL 2824 - GREENGUARD Certification Program Method for Measuring Microbial Resistance from Various Sources Using Static Environmental Chambers; Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.

C. Shop Drawings: Indicate seaming plans and floor patterns.

D. Verification Samples: Submit two samples, full in size illustrating color and pattern for each resilient flooring product specified.

E. Sustainable Design Submittal: Submit VOC content documentation for flooring and adhesives.

F. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.

G. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of subfloor is acceptable.

H. Manufacturer's Qualification Statement.

I. Installer's Qualification Statement.

J. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

K. 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: 10 square feet of each type and color.
   3. Extra Wall Base: 8 linear feet of each type and color.

1.5 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

C. Testing Agency Qualifications: Independent firm specializing in performing concrete slab moisture testing and inspections of the type specified in this section.

1.6 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.

1.7 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

2.1 TILE FLOORING

A. Vinyl Tile - Type RF-02: Solid vinyl with color and pattern throughout thickness.
   1. Manufacturers:
      a. Basis of Design: Patcraft Flooring ; www.patcraft.com
      b. Mannington Commercial; _____: www.manningtoncommercial.com#sle.
      c. Mohawk Group; www.mohawkgroup.com
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Minimum Requirements: Comply with ASTM F1700, of Class corresponding to type specified.
   3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
   4. Mold and Microbial Resistance: Highly resistant when tested in accordance with ASTM D6329; certified in accordance with UL 2824.
   5. VOC Content Limits: As specified in Section 01 61 16.
   6. Plank Tile Size: 6 by 36 inch.
   7. Wear Layer Thickness: 20mil (0.5mm)
   8. Total Thickness: 0.125 inch.
   9. Pattern: Crossover - Loose Lay.
   10. Color: Basis of Design As indicated on drawings.

11. Installation: Monolithic, refer to floor finish plan sheet for directional information.

B. Rubber Tile - Type RF-01: Homogeneous, color and pattern throughout thickness.
   1. Manufacturers:
      a. Mannington Commercial: www.manningtoncommercial.com#sle.
      b. Mohawk Group: www.mohawkgroup.com
      c. Basis of Design: Interface/Nora: https://www.nora.com.
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Minimum Requirements: Comply with ASTM F1344, of Class corresponding to type specified.
   3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
   4. Size: 40 by 40 inch nominal.
   5. Total Thickness: .14 inch (3.5 mm)
   6. Texture: Smooth.
   7. Pattern: norament castello.
   8. Color: As indicated on drawings.

2.2 RESILIENT BASE

A. Resilient Base - Type VB-01; VB-02: ASTM F1861, Type TV, vinyl, thermoplastic; Style B, Cove.
   1. Manufacturers:
      a. Flexco Corporation: www.flexcofloors.com/#sle.
      b. Basis of Design: Johnsonite, a Tarkett Company: www.johnsonite.com/#sle.
      c. Mannington Commercial: www.manningtoncommercial.com#sle.
      d. Roppe Corporation: www.roppe.com/#sle.
      e. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Height: 4 inches.
   3. Thickness: 0.125 inch.
   4. Finish: Satin.
   5. Length: 4 foot sections.
   6. Profiles: As indicated on drawings.
   7. Color: As indicated on drawings.

2.3 ACCESSORIES

A. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.

B. Adhesive for Vinyl Flooring: Use manufacturer recommended adhesive.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
   1. Test in accordance with Section 09 05 61.
   2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
   3. Follow moisture and alkalinity remediation procedures in Section 09 05 61.

D. Verify that required floor-mounted utilities are in correct location.

3.2 PREPARATION

A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

3.3 INSTALLATION - GENERAL

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install in accordance with manufacturer's written instructions.

C. Adhesive-Applied Installation:
   1. Spread only enough adhesive to permit installation of materials before initial set.
   2. Fit joints and butt seams tightly.
   3. Set flooring in place, press with heavy roller to attain full adhesion.

D. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

E. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated refer to architctural drawings.
   1. Metal Strips: Attach to substrate before installation of flooring using stainless steel screws.

F. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.4 INSTALLATION - TILE FLOORING

A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

B. Install plank tile with a random offset of at least 6 inches from adjacent rows.

3.5 INSTALLATION - RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.

B. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.

C. Install base on solid backing. Bond tightly to wall and floor surfaces.

D. Scribe and fit to door frames and other interruptions.

3.6 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

B. Clean in accordance with manufacturer's written instructions.

3.7 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

1.1 SECTION INCLUDES

A. Carpet tile, fully adhered.

1.2 RELATED REQUIREMENTS

A. Section 01 74 19 - Construction Waste Management and Disposal: Reclamation/Recycling of new carpet tile scrap and removed carpet tile.

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 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

1.3 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. 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.

F. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.4 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. Shop Drawings:
   1. Include carpet tile rendering diagram.
   2. Indicate layout of joints.

D. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.

E. Accessory Samples: Submit two 6 inch long samples of edge strip and base cap.

F. Sustainable Design Submittal: Submit VOC content documentation for adhesives.

G. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

H. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.

I. Manufacturer's Qualification Statement.

J. Installer's Qualification Statement.

K. Operation and Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

L. 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.

1.5 QUALITY ASSURANCE

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

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

1.6 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Tile Carpeting:
   1. Basis of Design: Interface, Inc: www.interface.com/#sle.
   2. Mohawk Group: www.mohawkgroup.com/#/.sle.
   3. Milliken & Company: www.milliken.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MATERIALS

A. Walkoff Carpeting, Type CP-01:
   1. Product: Step and Repeat manufactured by Interface.
   2. Tile Size: 50cm x 50cm, nominal.
   3. Color: 104945 Onyx.
   4. Pattern: Step and Repeat Collection; SR999
   5. Install pattern: Monolithic

B. Tile Carpeting, Type CP-02: Tufted, manufactured in one color dye lot.

1. Product: Woven Gradience Collection manufactured by Interface.
2. Tile Size: 50cm x 50 cm, nominal.
3. Color: 108053 Ash.
4. Pattern: Woven Gradience Collection; WG 100
5. Install pattern: Monolithic
6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

C. Tile Carpeting, Type[CP-03]: Tufted, manufactured in one color dye lot.
1. Product: [Woven Gradience Collection] manufactured by [Interface].
2. Tile Size: 50cm x 50cm, nominal.
3. Color: 107664 Ash/Greige
4. Pattern: Woven Gradience Collection; WG 200
5. Install Pattern: Monolithic
6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

D. Tile Carpeting, Type [CP-04]: Tufted, manufactured in one color dye lot.
1. Product: [Woven Gradience Collection] manufactured by [Interface].
2. Tile Size: 50cm x 50cm, nominal.
3. Color: 108049 Greige
4. Pattern: Woven Gradience Collection; WG 100
5. Install Pattern: Monolithic
6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

E. Tile Carpeting, Type [CP-05]: Tufted, manufactured in one color dye lot.
1. Product: [Woven Gradiance Collection] manufactured by [Interface]
2. Tile Size: 50cm x 50xm, nominal.
3. Color: Greige/Pine
4. Pattern: Woven Gradiance Collection; WG 200
5. Install pattern: Monolithic
6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

F. Tile Carpeting, Type [CP-06]: Tufted, manufactured in one color dye lot.
1. Product: [Woven Gradience Collection] manufactured by [Interface].
2. Tile Size: 50cm x 50cm, nominal.
3. Color: 108058 Pine
4. Pattern: Woven Gradience Collection; WG 100
5. Install Pattern: Monolithic
6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

G. Tile Carpeting, Type [CP-07]: Tufted, manufactured in one color dye lot.
1. Product: [Woven Gradience Collection] manufactured by [Interface].

2. Tile Size: 50cm x 50cm, nominal.Color: 107664 Ash/GreigePattern: Woven Gradience Collection; WG 100Install Pattern: Ashlar
3. Color: Greige/Navy
4. Pattern: Woven Gradience Collection; WG 200
5. Install Pattern: Monolithic
6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

H. Tile Carpeting, Type [CP-08]: Tufted, manufactured in one color dye lot.
1. Product: [Woven Gradience Collection] manufactured by [Interface].
2. Tile Size: 50cm x 50cm, nominal.
3. Color: 108061 Navy
4. Pattern: Woven Gradience Collection; WG 100
5. Install Pattern: Monolithic
6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

I. Tile Carpeting, Type [CP-09]: Tufted, manufactured in one color dye lot.
1. Product: [Flor] manufactured by [Interface].
2. Tile Size: 50cm x 50cm, nominal.
3. Color: Emerald
4. Pattern: Check it Out; 21-1553
5. Install Pattern: Monolithic
6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

2.3 ACCESSORIES

A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.

B. Edge Strips: Embossed aluminum, color as selected by Architect.

C. Adhesives:
1. Compatible with materials being adhered; maximum VOC content of 50 g/L; CRI (GLP) certified; in lieu of labeled product, independent test report showing compliance is acceptable.

D. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION

3.1 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. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.
   3. Follow moisture and alkalinity remediation procedures in Section 09 05 61.

E. Verify that required floor-mounted utilities are in correct location.

3.2 PREPARATION

A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

3.3 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install carpet tile in accordance with manufacturer's instructions.

C. Blend carpet from different cartons to ensure minimal variation in color match.

D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.

E. Lay carpet tile in pattern as indicated in Materials section per carpet type. Reference manufacturers installation rendering.

F. Locate change of color or pattern between rooms under door centerline.

G. Fully adhere carpet tile to substrate.

H. Trim carpet tile neatly at walls and around interruptions.

I. Complete installation of edge strips, concealing exposed edges.

3.4 CLEANING

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

B. Remove excess adhesive without damage, from floor, base, and wall surfaces.

C. Clean and vacuum carpet surfaces.

END OF SECTION 09 68 13

SECTION 09 72 00
WALL COVERINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface preparation and prime painting.

B. Wall covering and borders.

1.2 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

1.3 PRICE AND PAYMENT PROCEDURES

A. Wall covering work will be accomplished under one or more allowances.

B. See Section 01 21 00 - Allowances, for additional requirements.

C. Allowance includes purchase and delivery only.

1.4 REFERENCE STANDARDS

A. ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems; 2020.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

C. ASTM F793/F793M - Standard Classification of Wall Coverings by Use Characteristics; 2020.

1.5 SUBMITTALS

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

B. Product Data: Provide data on wall covering and adhesive.

C. Shop Drawings: Indicate wall elevations with seaming layout.

D. Samples: Submit two samples of wall covering, 24" by 24" inch in size illustrating color, finish, and texture.

E. Test Reports: Indicate verification of flame and smoke ratings, when tested by UL.

F. Manufacturer's Installation Instructions: Indicate special procedures.

G. Maintenance Data: Submit data on cleaning, touch-up, and repair of covered surfaces.

H. Manufacturer's Qualification Statement.

I. Installer's Qualification Statement.

J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Wall Covering Materials: 25 linear feet of each color and pattern of wall covering; store where directed.
   3. Package and label each roll by manufacturer, color and pattern, and destination room number.

1.6 QUALITY ASSURANCE

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspect roll materials at arrival on site, to verify acceptability.

B. Protect packaged adhesive from temperature cycling and cold temperatures.

C. Do not store roll goods on end.

1.8 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the adhesive or wall covering product manufacturer.

B. Maintain these conditions 24 hours before, during, and after installation of adhesive and wall covering.

C. Provide lighting level of 80 ft candles measured mid-height at substrate surfaces.

PART 2 PRODUCTS

2.1 WALL COVERINGS

A. General Requirements:
   1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.

B. Wall Covering: WC-01
   1. Content: Acoustic wallcovering; 100% polyester
   2. Dimensions: 47.9" x 90.7"
   3. Collection: GATHER Acoustical
   4. Pattern: Basket (BSKT)
   5. Color: Sienna 701
   6. Repeat: Vertical; this product is made to measure, repeat to be fitted to space.
   7. Manufacturers:
      a. Basis of Design: Wolf Gordon: www.wolfgordon.com
      b. Momentum Textiles: www.memosamples.com#sle
      c. Basis of Deisgn: Wolf-Gordon: www.wolfgordon.com/#sle.

d. _____.

C. Wall Covering: WC-02
1. Content: UV Printed ASTM F793 Type II Class A Wallcovering
2. Total Weight: 18 oz/ linear yard.
3. Roll Width: 50 inches.
4. Weight: 18.0 oz.
5. Cutting Direction: NR - Non-Railroaded
6. Backing: Non-woven, synthetic fabric.
7. Color: As indicated on drawings.
8. Contents: 86% Thermoplastic Olefin, 14% Post-Consumer Recycled Glass
9. Environmental: Contains Recycled Content, Free of intentionally added PFAS
10. Manufacturers:
a. MDC Interior Solutions: www.mdcwall.com/#sle.
b. Maharam; www.maharam.com
c. Basis of Deisgn: Wolf-Gordon[<>]: www.wolfgordon.com/#sle.
d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Termination Trim: Extruded plastic, clear.

E. Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are prime painted and ready to receive work, and comply with requirements of wall covering manufacturer.

B. Measure moisture content of surfaces using an electronic moisture meter. Do not apply wall coverings if moisture content of substrate exceeds level recommended by wall covering manufacturer.

C. Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet nor vary at a rate greater than 1/16 inch/ft.

3.2 PREPARATION

A. Fill cracks in substrate and smooth irregularities with filler; sand smooth.

B. Wash impervious surfaces with tetra-sodium phosphate, rinse and neutralize; wipe dry.

C. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

D. Surfaces: Correct defects and clean surfaces that affect work of this section. Remove existing coatings that exhibit loose surface defects.

E. Vacuum clean surfaces free of loose particles.

3.3 INSTALLATION

A. Apply adhesive and wall covering in accordance with manufacturer's instructions.

B. Apply adhesive to wall surface immediately prior to application of wall covering.

C. Razor trim edges on flat work table. Do not razor cut on gypsum board surfaces.

D. Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface.

E. Butt edges tightly.

F. Overlap adjacent panels as recommended by manufacturer.

G. Horizontal seams are not acceptable.

H. Do not seam within 2 inches of internal corners or within 6 inches of external corners.

I. Install wall covering before installation of bases and items attached to or spaced slightly from wall surface.

J. Do not install wall covering more than 1/4 inch below top of resilient base.

K. Where wall covering tucks into reveals, or metal wallboard or plaster stops, apply with contact adhesive within 6 inches of wall covering termination. Ensure full contact bond.

L. Install termination trim.

M. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.4 CLEANING

A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.

B. Reinstall wall plates and accessories removed prior to work of this section.

3.5 PROTECTION

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

END OF SECTION 09 72 00

SECTION 09 91 13
EXTERIOR PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
   1. Exposed surfaces of steel lintels and ledge angles.

D. Do Not Paint or Finish the Following Items:
   1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
   5. Non-metallic roofing and flashing.
   6. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, zinc, and lead.
   7. Marble, granite, slate, and other natural stones.
   8. Floors, unless specifically indicated.
   9. Ceramic and other types of tiles.
   10. Brick, glass unit masonry, architectural concrete, cast stone, integrally colored plaster and stucco.
   11. Glass.
   12. Concealed pipes, ducts, and conduits.

1.2 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting.

1.3 DEFINITIONS

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

1.4 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2023.

C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2020.

D. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.

E. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

F. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

1.5 SUBMITTALS

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

B. Product Data: Provide complete list of products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
   2. MPI product number (e.g. MPI #47).
   3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
   4. Manufacturer's installation instructions.

C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
   1. Where sheen is specified, submit samples in only that sheen.
   2. Paint color submittals will not be considered until color submittals for major materials not to be painted, such as masonry, have been approved.

D. Certification: By manufacturer that paints and finishes comply with VOC limits specified.

E. Manufacturer's Instructions: Indicate special surface preparation procedures.

F. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Paint and Finish Materials: 1 gallon of each color; from the same product run, store where directed.
   3. Label each container with color in addition to the manufacturer's label.

1.6 QUALITY ASSURANCE

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

B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

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

1.8 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the paint product manufacturer's temperature ranges.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Do not apply exterior paint and finishes during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

D. Minimum Application Temperatures for Latex Paints: 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide paints and finishes from the same manufacturer to the greatest extent possible.
   1. If a single manufacturer cannot provide specified products, minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.

B. Paints:
   1. PPG Paints: www.ppgpaints.com/#sle.
   2. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
   3. Benjamin Moore & Co..

C. Primer Sealers: Same manufacturer as top coats.

2.2 PAINTS AND FINISHES - GENERAL

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

B. Volatile Organic Compound (VOC) Content:
   1. Provide paints and finishes that comply with the most stringent requirements specified in the following:

a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.

2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

C. Flammability: Comply with applicable code for surface burning characteristics.

D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

E. Colors: As indicated on drawings.

2.3 PAINT SYSTEMS - EXTERIOR

A. Exterior Surfaces to be Painted, Unless Otherwise Indicated: Including fiber cement siding and primed wood.
1. Two top coats and one coat primer.
2. Top Coat(s): Exterior Latex; MPI #10, 11, 15, 119, or 214.
3. Primer: As recommended by top coat manufacturer for specific substrate.

B. Ferrous Metals, Unprimed, Alkyd, 3 Coat:
1. One coat of alkyd primer.
2. Gloss: Two coats of alkyd enamel.

C. Ferrous Metals, Primed, Alkyd, 2 Coat:
1. Touch-up with rust-inhibitive primer recommended by top coat manufacturer.
2. Gloss: Two coats of alkyd enamel.

D. Galvanized Metals, Latex, 3 Coat:
1. One coat galvanize primer.
2. Gloss: Two coats of latex enamel.

2.4 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin application of paints and finishes until substrates have been properly prepared.

B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

E. Test shop-applied primer for compatibility with subsequent cover materials.

F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
   1. Fiber Cement Siding: 12 percent.
   2. Exterior Wood: 15 percent, measured in accordance with ASTM D4442.

3.2 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

F. Fiber Cement Siding: Remove dirt, dust and other foreign matter with a stiff fiber brush. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

G. Galvanized Surfaces:
   1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.

H. Ferrous Metal:
   1. Solvent clean according to SSPC-SP 1.
   2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
   3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 Commercial Blast Cleaning. Protect from corrosion until coated.

I. Exterior Wood Surfaces to Receive Opaque Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior calking compound after prime coat has been applied. Back prime concealed surfaces before installation.

3.3 APPLICATION

A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

B. Exterior Wood to Receive Opaque Finish: If final painting must be delayed more than 2 weeks after installation of woodwork, apply primer within 2 weeks and final coating within 4 weeks.

C. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

D. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

E. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

F. Apply each coat to uniform appearance.

G. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply additional coats until complete hide is achieved.

H. Sand wood and metal surfaces lightly between coats to achieve required finish.

I. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

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

3.4 CLEANING

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

3.5 PROTECTION

A. Protect finishes until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 91 13

SECTION 09 91 23
INTERIOR PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
   1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.

D. Do Not Paint or Finish the Following Items:
   1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
   5. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, and lead items.
   6. Marble, granite, slate, and other natural stones.
   7. Floors, unless specifically indicated.
   8. Ceramic and other tiles.
   9. Brick, architectural concrete, cast stone, integrally colored plaster, and stucco.
   10. Glass.
   11. Concrete masonry units in utility, mechanical, and electrical spaces.
   12. Acoustical materials, unless specifically indicated.
   13. Concealed pipes, ducts, and conduits.

1.2 RELATED REQUIREMENTS

A. Section 09 91 13 - Exterior Painting.

1.3 DEFINITIONS

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

1.4 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2023.

C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2020.

D. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.

E. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

F. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

1.5 SUBMITTALS

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

B. Product Data: Provide complete list of products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
   2. MPI product number (e.g., MPI #47).
   3. Cross-reference to specified paint system products to be used in project; include description of each system.
   4. Manufacturer's installation instructions.

C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
   1. Where sheen is specified, submit samples in only that sheen.

D. Certification: By manufacturer that paints and finishes comply with VOC limits specified.

E. Manufacturer's Instructions: Indicate special surface preparation procedures.

F. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Paint and Finish Materials: 1 gal of each color; from the same product run, store where directed.
   3. Label each container with color in addition to the manufacturer's label.

1.6 QUALITY ASSURANCE

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

B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

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

1.8 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F above the dew point, or to damp or wet surfaces.

D. Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 fc measured mid-height at substrate surface.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide paints and finishes from the same manufacturer to the greatest extent possible.
   1. If a single manufacturer cannot provide specified products; minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.

B. Paints:
   1. Base Manufacturer: Sherwin Williams, www.sherwin-williams.com/#sle.
   2. Benjamin Moore & Co.
   3. PPG Paints: www.ppgpaints.com/#sle.

C. Primer Sealers: Same manufacturer as top coats.

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

2.2 PAINTS AND FINISHES - GENERAL

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

B. Volatile Organic Compound (VOC) Content:
   1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
      a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.

2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

C. Flammability: Comply with applicable code for surface burning characteristics.

D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

E. Colors: As indicated on drawings.

2.3 PAINT SYSTEMS - INTERIOR

A. Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board.
1. Two top coats and one coat primer.
2. Top Coat(s): High Performance Architectural Interior Latex.
a. Products:
1) Sherwin Williams Harmony.
2) Substitutions: See Section 01 60 00 - Product Requirements

B. Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals and wood:
1. Two top coats and one coat primer.
2. Top Coat(s): Interior Epoxy-Modified Latex.
a. Products:
1) Sherwin Williams Metalatex.
2) Substitutions: See Section 01 60 00 - Product Requirements

2.4 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin application of paints and finishes until substrates have been adequately prepared.

B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

E. Test shop-applied primer for compatibility with subsequent cover materials.

F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
   1. Gypsum Wallboard: 12 percent.
   2. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.2 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or repair existing paints or finishes that exhibit surface defects.

D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

E. Seal surfaces that might cause bleed through or staining of topcoat.

F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

G. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.

H. Galvanized Surfaces:
   1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.

I. Ferrous Metal:
   1. Solvent clean according to SSPC-SP 1.
   2. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 Commercial Blast Cleaning. Protect from corrosion until coated.

J. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

3.3 APPLICATION

A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.

D. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.

E. Sand wood and metal surfaces lightly between coats to achieve required finish.

F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

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

3.4 CLEANING

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

3.5 PROTECTION

A. Protect finishes until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 91 23

SECTION 09 93 00
STAINING AND TRANSPARENT FINISHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Field application of stains.

1.2 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting

1.3 DEFINITIONS

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

1.4 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2023.

C. CARB (SCM) - Suggested Control Measure for Architectural Coatings; California Air Resources Board; 2020.

D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.

E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.

F. SCAQMD 1113 - Architectural Coatings; 1977, with Amendment (2016).

1.5 SUBMITTALS

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

B. Product Data: Provide complete list of products to be used, with the following information for each:
   1. Manufacturer's name, product name and catalog number, and general product category.
   2. Manufacturer's installation instructions.
   3. If proposal of substitutions is allowed under submittal procedures, explanation of substitutions proposed.

C. Samples: Two samples on representative sample, 12 by 12 inch in size, indicating selected colors and sheens for each system, with specified coats cascaded.

D. Certification: By manufacturer that stains and transparent finishes comply with VOC limits specified.

E. Manufacturer's Instructions: Indicate special surface preparation procedures.

F. Manufacturer's Qualification Statement.

G. Applicator's Qualification Statement.

H. Maintenance Data: Submit data including finish schedule showing where each product, color, and finish was used, product technical data sheets, safety data sheets (SDS), care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements for additional provisions.
   2. Extra Stock Materials: Stain and transparent finish materials, 1 gal of each color and type; store where directed.
      a. Label each container with color and type in addition to the manufacturer's label.

1.6 QUALITY ASSURANCE

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

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

1.7 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 stain or transparent finish, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

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

1.8 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by manufacturer of stains and transparent finishes.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F above the dew point, or to damp or wet surfaces.

D. Minimum Application Temperature: 50 degrees F unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 fc measured mid-height at substrate surface.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide finishes used in any individual system from the same manufacturer; no exceptions.

B. Stains:
   1. Behr Process Corporation: www.behr.com/#sle.
   2. Bona US: www.bona.com/#sle.
   3. PPG Paints: www.ppgpaints.com/#sle.
   4. Basis of Design: Sherwin-Williams Company; Classic Wood Stain: www.sherwin-williams.com/#sle.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 STAINS AND TRANSPARENT FINISHES - GENERAL

A. Finishes:
   1. Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI categories, except as otherwise indicated.
   2. Provide finishes capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
   3. Provide materials compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
   4. Supply each finish material in quantity required to complete entire project's work from a single production run.
   5. Do not reduce, thin, or dilute finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

B. Volatile Organic Compound (VOC) Content:
   1. Provide stains and transparent finishes that comply with the most stringent requirements specified in the following:
      a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
      b. SCAQMD 1113 Rule.
      c. CARB (SCM).
   2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

C. Flammability: Comply with applicable code for surface burning characteristics.

D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

E. Colors: As indicated on drawings.

2.3 INTERIOR STAIN AND TRANSPARENT FINISH SYSTEMS

A. Finish on Wood:

1. Two-coat stain.
2. One-coat sealer.
3. Stain: Semi-transparent stain for wood, water based; MPI #186.
4. Sealer: Water based, sanding sealer, clear.
5. Top Coat: Clear water-based varnish; MPI #128, 129, or 130.
6. Top Coat Sheen:
   a. Satin: MPI gloss level 4; use this sheen at all locations.

2.4 ACCESSORY MATERIALS

A. Accessory Materials: Cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of finished surfaces.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin application of stains and finishes until substrates have been properly prepared.

B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.

D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or repair existing finishes that exhibit surface defects.

D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

E. Seal surfaces that might cause bleed through or staining of topcoat.

F. Wood Surfaces to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.

3.3 APPLICATION

A. Apply products in accordance with manufacturer's written instructions.

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.

D. Sand wood surfaces lightly between coats to achieve required finish.

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

F. Reinstall items removed prior to finishing.

3.4 CLEANING

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

3.5 PROTECTION

A. Protect finishes until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 93 00

SECTION 10 11 00
VISUAL DISPLAY UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Porcelain enamel steel markerboards.

B. Tackboards.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Blocking and supports.

1.3 REFERENCE STANDARDS

A. ANSI A208.1 - American National Standard for Particleboard; 2022.

B. ASTM A424/A424M - Standard Specification for Steel, Sheet, for Porcelain Enameling; 2018.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

D. PS 1 - Structural Plywood; 2023.

1.4 SUBMITTALS

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

B. Product Data: Provide manufacturer's data on porcelain enamel steel markerboard, trim, and accessories.

C. Shop Drawings: Indicate wall elevations, dimensions, joint locations , special anchor details.

D. Samples: Color charts for selection of color and texture of porcelain enamel steel markerboard and trim.

E. Test Reports: Show compliance to specified surface burning characteristics requirements.

F. Manufacturer's printed installation instructions.

G. Manufacturer's Qualification Statement.

1.5 QUALITY ASSURANCE

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

1.6 WARRANTY

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

B. Provide five year warranty for markerboard to include warranty against discoloration due to cleaning, crazing or cracking, and staining.

PART 2 PRODUCTS

2.1 VISUAL DISPLAY UNITS

A. Porcelain Enamel Steel Magnetic Markerboards:
   1. Manufacturers:
      a. ASI Visual Display Products: www.asi-visualdisplayproducts.com/#sle.
      b. Basis of Design: Claridge Products and Equipment, Inc: www.claridgeproducts.com/#sle.
      c. Nelson Adams NACO: www.nelsonadamsnaco.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Color: White.
   3. Steel Face Sheet Thickness: 24 gauge, 0.0239 inch .
   4. Core: Particleboard, manufacturer's standard thickness, laminated to face sheet.
   5. Backing: Aluminum foil, laminated to core.
   6. Size: As indicated on drawings.
   7. Frame Finish: Anodized, natural.
   8. Accessories: Provide marker tray and map rail.

B. Tackboards: Fabric laminated to cork.
   1. Manufacturers:
      a. ASI Visual Display Products: www.asi-visualdisplayproducts.com/#sle.
      b. Basis of Design: Claridge Products and Equipment, Inc: www.claridgeproducts.com/#sle.
      c. Nelson Adams NACO: www.nelsonadamsnaco.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Cork Thickness: 1/4 inch.
   3. Fabric: Manufacturer's standard fabric.
   4. Color: As selected from manufacturer's full range.
   5. Backing: Hardboard, 1/4 inch thick, laminated to tack surface.
   6. Surface Burning Characteristics: Flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.
   7. Size: As indicated on drawings.
   8. Frame Finish: Fabric edge wrapped.

2.2 MATERIALS

A. Porcelain Enameled Steel Sheet: ASTM A424/A424M, Type I, Commercial Steel, with fired-on vitreous finish.

B. Plywood: PS 1 Grade C-D , softwood.

C. Particleboard: ANSI A208.1; wood chips, set with waterproof resin binder, sanded faces.

D. Foil Backing: Aluminum foil sheet, 0.005 inch thick.

E. Adhesives: Type used by manufacturer.

2.3 ACCESSORIES

A. Map Rail: Extruded aluminum, manufacturer's standard profile, with cork insert and runners for accessories; 1 inch wide overall , full width of frame.

B. Temporary Protective Cover: Sheet polyethylene, 8 mil thick.

C. Mounting Brackets: Concealed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

3.2 PREPARATION

A. Acclimatize tackable wall panels by removing from packaging in installation area not less than 24 hours before application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install boards in accordance with manufacturer's instructions.

B. Secure units level and plumb.

C. Install tackable wall panels in accordance with manufacturer's recommendations on specified substrates with concealed attachments.

3.4 CLEANING

A. Clean board surfaces in accordance with manufacturer's instructions.

B. Cover with protective cover, taped to frame.

C. Remove temporary protective cover at Date of Substantial Completion.

END OF SECTION 10 11 00

SECTION 10 14 16
PLAQUES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Plaques.

1.2 REFERENCE STANDARDS

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.

B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

C. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.3 SUBMITTALS

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

B. Product Data: Manufacturer's product literature for each type of plaque sign, indicating style, font, foreground and background colors, locations, and overall dimensions of each sign.

C. Shop Drawings: Indicate dimensions, locations, elevations, materials, text and graphic layout, and attachment details.

D. Selection Samples: Where materials, colors, and finishes are not specified, submit two sets of color selection charts or chips.

E. Manufacturer's qualification statement.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Package plaque signs as required to prevent damage before installation.

B. Store under cover and elevated above grade.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Accessibility Requirements: Comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most restrictive requirements.

2.2 PLAQUES

A. Metal Plaques:
   1. Material: Bronze casting.
   2. Material Thickness: 1/4 inch, minimum.
   3. Size: 12 inches by 16 inches.
   4. Text and Typeface:
      a. Character Case: Upper case only.
      b. Character Color: Dark Bronze color.
   5. Surface Finish: As selected by Architect from manufacturer's full range.
   6. Stained Background Color: Dark bronze.
   7. Protective Coating: Manufacturer's standard clear coating.
   8. Mounting: Rosettes and toggle bolts.

2.3 ACCESSORIES

A. Concealed Screws: Noncorroding metal; other.

B. Exposed Screws: Brass plated.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Notify Architect if conditions are not suitable for installation of signs; do not proceed until conditions are satisfactory.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install with horizontal edges level.

C. Locate plaque signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.

D. Protect from damage until 04-30-2025; repair or replace damaged items.

END OF SECTION 10 14 16

SECTION 10 14 23
PANEL SIGNAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Code required panel signage.

1.2 REFERENCE STANDARDS

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

B. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.3 SUBMITTALS

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

B. Product Data: Manufacturer's product literature for each type of panel sign, indicating styles, font, foreground and background colors, locations, and overall dimensions of each sign.

C. Shop Drawings:
   1. Include dimensions, locations, elevations, materials, text and graphic layout, attachment details, and schedules.
   2. Schedule: Provide information sufficient to completely define each panel sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
      a. When room numbers to appear on signs differ from those on drawings, include the drawing room number on schedule.
      b. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
      c. Submit for approval by Owner through Architect prior to fabrication.

D. Samples: Submit two samples of each type of sign, of size similar to that required for project, indicating sign style, font, and method of attachment.

E. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

F. Manufacturer's qualification statement.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Package signs as required to prevent damage before installation.

B. Package room and door signs in sequential order of installation, labeled by floor or building.

C. Store under cover and elevated above grade.

D. Store tape adhesive at normal room temperature.

1.6 FIELD CONDITIONS

A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.

B. Maintain minimum ambient temperature during and after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Panel Signage:
1. Best Sign Systems, Inc: www.bestsigns.com/#sle.
2. FASTSIGNS International, Inc: www.fastsigns.com/#sle.
3. Inpro Corporation: www.inprocorp.com/#sle.
4. Mohawk Sign Systems, Inc: www.mohawksign.com/#sle.
5. Seton Identification Products: www.seton.com/aec/#sle.
6. Takeform: www.takeform.net/#sle.
7. Vista System LLC: www.vistasystem.com/#sle.
8. Essential Architectural Signs: www.essentialsigns.com
9. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 REGULATORY REQUIREMENTS

A. Accessibility Requirements: Comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most restrictive requirements.

2.3 PANEL SIGNAGE

A. Panel Signage:
1. Application: Room and door signs.
2. Description: Flat signs with tactile characters.
3. Sign Design: Per Owner's campus signage standards.
4. Total Thickness: 1/8 inch minimum.
5. Tactile Letters: Raised 1/32 inch minimum.
6. Braille: Grade II, ADA-compliant.
7. One-Sided Wall Mounting: Concealed or exposed screws.

2.4 SIGNAGE APPLICATIONS

A. Room and Door Signs:
1. Service Rooms: Identify with room names and numbers to be determined later, not those indicated on drawings.
2. Rest Rooms: Identify with pictograms and names, room numbers to be determined later, and braille.

B. Interior Directional and Informational Panel Signs:

C. Emergency Evacuation Map Panel Signs:
   1. Map content to be provided by Owner.

2.5 ACCESSORIES

A. Concealed Screws: Noncorroding metal; stainless steel, galvanized steel, chrome plated, or other.

B. Exposed Screws: Chrome plated.

C. Tape Adhesive: Double-sided tape, permanent adhesive.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Notify Architect if conditions are not suitable for installation of signs; do not proceed until conditions are satisfactory.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install with horizontal edges level.

C. Locate panel signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.

D. Protect from damage as required, repair or replace damaged items.

END OF SECTION 10 14 23

SECTION 10 26 00
WALL AND DOOR PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Corner guards.

1.2 RELATED REQUIREMENTS

A. Section 08 71 00 - Door Hardware: Standard protection plates and trim.

B. Section 09 72 00 - Wall Coverings: Terminating wall covering at wall and door protection.

1.3 REFERENCE STANDARDS

A. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2023, with Editorial Revision.

B. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents; 2021.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

D. ASTM F476 - Standard Test Methods for Security of Swinging Door Assemblies; 2023.

E. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

1.4 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. Samples: Submit samples illustrating component design, configurations, joinery, full range of colors and finishes.

E. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.

F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Stock Materials: One of each color of corner guards in the longest length specified.

H. 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.

1.5 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. Protect work from UV light damage.

D. 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.

E. Store products in either horizontal or vertical position, in compliance with manufacturer's instructions.

1.6 WARRANTY

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Corner Guards:
   1. Construction Specialties, Inc: www.c-sgroup.com/#sle.
   2. Basis of Design: Inpro: Koroseal Interior Products
   3. Inpro Wall Protection: www.inpro.com
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 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.

B. Chemical and Stain Resistance: Unless otherwise noted, provide protection products and assemblies with chemical and stain resistance complying with applicable provisions of ASTM D543.

C. Fungal Resistance: Unless otherwise noted, provide protection products and assemblies which pass ASTM G21 testing.

2.3 PRODUCT TYPES

A. Corner Guards - Flush Mounted:
   1. Material: High impact vinyl with full height extruded aluminum retainer.
   2. Performance: Resist lateral impact force of 100 lbs at any point without damage or permanent set.

3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
4. Width of Wings: 2 inches.
5. Corner: Square.
6. Color: As selected from manufacturer's standard colors.
7. Length: One piece.
8. Basis of Design: Koroguard tape on corner guard

B. Corner Guards - Surface Mounted Tape-on:
1. Material: High impact vinyl.
2. Performance: Resist lateral impact force of 100 lbs at any point without damage or permanent set.
3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
4. Width of Wings: 2 inches.
5. Corner: Square.
6. Color: As selected from manufacturer's standard colors.
7. Length: One piece.

2.4 FABRICATION

A. Fabricate components with tight joints, corners and seams.

2.5 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Control Services, for additional requirements.

B. Provide wall and door protection systems of each type from a single source and manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that rough openings 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.

3.2 INSTALLATION

A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.

B. Position corner guard 4 inches above finished floor to minimum 40 inches high or as indicated on drawings.

C. Coordinate installation of vinyl fabric wall covering specified in Section 09 72 00.

3.3 TOLERANCES

A. Maximum Variation From Required Height: 1/4 inch.

B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch.

3.4 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 28 00
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Commercial toilet accessories.

B. Under-lavatory pipe supply covers.

1.2 RELATED REQUIREMENTS

A. Section 06 10 53: Concealed supports for accessories, including in wall framing and plates and above ceiling framing.

B. Section 22 40 00 - Plumbing Fixtures: Under-lavatory pipe and supply covers.

1.3 ABBREVIATIONS AND ACRONYMS

A. PETG: Polyethylene Terephthalate Glycol.

B. PPE: Personal Protective Equipment.

1.4 REFERENCE STANDARDS

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

B. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2022.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.

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 C1503 - Standard Specification for Silvered Flat Glass Mirror; 2018.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.6 SUBMITTALS

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

B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

C. Samples: Submit two samples of each material, illustrating color and finish.

D. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Commercial Toilet, Shower, and Bath Accessories:
   1. American Specialties, Inc: www.americanspecialties.com/#sle.
   2. Bradley Corporation: www.bradleycorp.com/#sle.
   3. Basis of Design:Bobrick Corporation; www.bobrick.com
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Electric Hand/Hair Dryers:
   1. Basis of Design: Dyson Inc: www.dyson.com/#sle.
   2. Excel Dryer: www.exceldryer.com/#sle.
   3. World Dryer Corporation: www.worlddryer.com/#sle.
   4. Substitutions: Section 01 60 00 - Product Requirements.

C. Provide products of each category type by single manufacturer.

2.2 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
   1. Grind welded joints smooth.
   2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.

B. Keys: Provide 2 keys for each accessory to Owner; master key lockable accessories.

C. Stainless Steel Sheet: ASTM A666, Type 304.

D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.

E. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.

F. Mirror Glass: Tempered safety glass, ASTM C1048; and ASTM C1036 Type I, Class 1, Quality Q2, with silvering as required.

G. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.3 FINISHES

A. Stainless Steel: Satin finish, unless otherwise noted.

2.4 COMMERCIAL TOILET ACCESSORIES

A. Toilet Paper Dispenser: Single Double roll, surface mounted bracket type, stainless steel, spindleless type for tension spring delivery designed to prevent theft of tissue roll.

B. Paper Towel Dispenser: Folded paper type, stainless steel, semi-recessed, with viewing slots on sides as refill indicator and tumbler lock.
   1. Capacity: 300 C-fold minimum.

C. Individual Mirrors: Stainless steel framed, 1/4 inch thick annealed float glass; ASTM C1036.
   1. Tempered Safety Glass: Silvering, protective and physical characteristics in compliance with ASTM C1503.
   2. Frame: 0.05 inchangle shapes, with mitered and welded and ground corners, and tamperproof hanging system; matte black finish.

D. Grab Bars: Stainless steel, peened surface.
   1. Standard Duty Grab Bars:
      a. Push/Pull Point Load: 250 pound-force, minimum.
      b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
      c. Finish: Peened.
      d. Length and Configuration: As indicated on drawings.

E. Clothes Hook: Single-prong, exposed attachment.
   1. Material: Aluminum casting, rubber protection bumper.

2.5 UNDER-LAVATORY PIPE AND SUPPLY COVERS

A. Specified in 22 40 00 - Plumbing Fixtures.

2.6 ELECTRIC HAND/HAIR DRYERS

A. Electric Hand Dryers:
   1. Operation: Automatic, sensor-operated on and off.
   2. Mounting: Varies.
   3. Cover: Stainless steel with brushed finish.
      a. Color: Brushed stainless steel.
      b. Tamper-resistant screw attachment of cover to mounting plate.
   4. Air Velocity: CFM: 28 min.
   5. Fan Control: Field adjustable down to approximately half-speed.
   6. Total Wattage: 1400 W., heater.
   7. Runtime: Field adjustable or automatic, up to 35 seconds.
   8. Wall Guards for Electric Hand Dryers: Match finish of dryer.
   9. Additional matching recess kit and mount required for units deeper than 4".

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify exact location of accessories for installation.

C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.

D. Verify that field measurements are as indicated on drawings.

E. See Section 06 10 53 for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings.

3.2 PREPARATION

A. Deliver inserts and rough-in frames to site for timely installation.

B. Provide templates and rough-in measurements as required.

3.3 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.

B. Install plumb and level, securely and rigidly anchored to substrate.

C. Mounting Heights: As indicated on drawings.

3.4 PROTECTION

A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 10 28 00

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fire extinguishers.

B. Fire extinguisher cabinets.

C. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

1.3 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.

B. FM (AG) - FM Approval Guide; Current Edition.

C. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.

D. UL (DIR) - Online Certifications Directory; Current Edition.

1.4 SUBMITTALS

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

B. Product Data: Provide extinguisher operational features, extinguisher ratings and classifications, color and finish, anchorage details, and installation instructions.

C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.

D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

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

F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.5 FIELD CONDITIONS

A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Fire Extinguishers:
   1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com/#sle.
   2. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
   3. Pyro-Chem, a Tyco Business: www.pyrochem.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Fire Extinguisher Cabinets and Accessories:
   1. Activar Construction Products Group, Inc. - 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.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
   1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.

B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
   1. Class: A:B:C type.
   2. Size: 5 pound.
   3. Finish: Baked polyester powder coat, color as selected.
   4. Temperature range: Minus 40 degrees F to 120 degrees F.

2.3 FIRE EXTINGUISHER CABINETS

A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.

B. Fire Rated Cabinet Construction:
   1. Steel; double wall or outer and inner boxes with 5/8 inch thick fire barrier material.

C. Cabinet Configuration: Semi-recessed type.
   1. Size to accommodate accessories.
   2. Trim: Flat rolled edge.

D. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with lock and breakable window access. Hinge doors for 180 degree opening with two butt hinges.

E. Door Glazing: Acrylic plastic, clear, 1/8 inch thick, flat shape and set in resilient channel glazing gasket.

F. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.

G. Fabrication: Weld, fill, and grind components smooth.

H. Finish of Cabinet Exterior Trim and Door: Baked enamel, color as selected.

I. Finish of Cabinet Interior: White colored enamel.

2.4 ACCESSORIES

A. Lettering: “FIRE EXTINGUISHER” decal, or vinyl self-adhering, prespaced black lettering in accordance with authorities having jurisdiction (AHJ).

B. Floor Signs:
   1. Floor Sign: 17-1/2 inch diameter vinyl sign with "DO NOT BLOCK FIRE EXTINGUISHER", directional arrow, and fire extinguisher icon.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify rough openings for cabinet are correctly sized and located.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure rigidly in place.

C. Place extinguishers in cabinets.

D. Position cabinet signage.

3.3 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 10 51 29
PHENOLIC LOCKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Phenolic lockers.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry Wood blocking and nailers.

1.3 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

1.4 SUBMITTALS

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

B. Product Data: Manufacturer's published data on locker construction, sizes and accessories.

C. Shop Drawings: Indicate locker plan layout, numbering plan and combination lock code.

D. Samples: Submit two samples 3 by 6 inches in size, of each color scheduled.

E. Manufacturer's Installation Instructions: Indicate component installation assembly.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect locker finish and adjacent surfaces from damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Phenolic Lockers:
   1. ASI Storage Solutions: www.asi-storage.com/#sle.
   2. Columbia Lockers, a division of PSiSC: www.psisc.com/#sle.
   3. List Industries, Inc: www.listindustries.com/#sle.
   4. Summit Lockers, Inc: www.summitlockers.com/#sle.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 LOCKER APPLICATIONS

A. Wardrobe Lockers: Phenolic lockers, wall mounted with matching closed base.
   1. Width: 12 inches.
   2. Depth: 12 inches.
   3. Depth: 12 inches.

4. Height: 72 inches.
5. Locker Configuration: Two tier.
6. Fittings: Size and configuration as indicated on drawings.
7. Locking: Padlock hasps, for padlocks provided by Owner.
8. Provide sloped top.

2.3 PHENOLIC LOCKERS

A. Lockers: Factory assembled, made of phenolic core panels with mortise and tenon joints and stainless steel mechanical joint fasteners; fully finished inside and out; each locker capable of standing alone.
   1. Doors: Full overlay, covering full width and height of locker body; square edges.
   2. Panel Core Exposed at Edges: Machine polished, without chips or tool marks; square edge unless otherwise indicated.
   3. Where locker ends or sides are exposed, finish the same as fronts or provide extra panels to match fronts.
   4. Provide filler strips as needed, securely attached to lockers.
   5. Door Color: As selected by Architect.
   6. Body Color: As selected by Architect
   7. Fasteners for Accessories and Locking Mechanisms: Tamperproof type.

B. Component Thicknesses:
   1. Doors: 1/2 inch minimum thickness.
   2. Locker Body: One of the following combinations:
   3. Sloped Tops: 1/2 inch minimum thickness.
   4. Toe Kick Plates: 1/2 inch minimum thickness.

C. Phenolic Core Panels: Nonporous phenolic resin and paper core formed under high pressure, with natural colored finished edges, integral melamine surface, matte finish, and uniform surface appearance; glued laminated panels not acceptable.
   1. Surface Burning Characteristics: Flame spread index of 75 or less, and smoke developed index of 450 or less; when tested in accordance with ASTM E84.

D. Number Plates: Manufacturer's standard, minimum 4-digit, permanently attached with adhesive; may be field installed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify bases and embedded anchors are properly sized.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install lockers plumb and square.

C. Secure lockers with anchor devices to suit substrate materials. Minimum Pullout Force: 100 pounds.

D. Bolt adjoining locker units together to provide rigid installation.

E. Install end panels, filler panels, and sloped tops.

F. Install accessories.

G. Replace components that do not operate smoothly.

3.3 CLEANING

A. Clean locker interiors and exterior surfaces.

END OF SECTION 10 51 29

SECTION 10 75 00
FLAGPOLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aluminum Flagpoles.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete base and foundation construction.

1.3 REFERENCE STANDARDS

A. AASHTO M 36 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains; 2016 (Reapproved 2020).

B. ASTM B241/B241M - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube; 2022.

C. NAAMM FP 1001 - Guide Specifications for Design Loads of Metal Flagpoles; 2007.

1.4 SUBMITTALS

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

B. Product Data: Provide data on pole, accessories, and configurations.

C. Shop Drawings: Indicate detailed dimensions, base details, anchor requirements, and imposed loads.

D. Designer's Qualification Statement.

E. Operation Data: Provide operating data for the controller and timer.

F. Maintenance Data: Provide lubrication and periodic maintenance requirement schedules.

1.5 QUALITY ASSURANCE

A. Designer Qualifications: Design flagpole foundation under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed Ohio.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Spiral wrap flagpole with protective covering and pack in protective shipping tubes or containers.

B. Protect flagpole and accessories from damage or moisture.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Flagpoles:
   1. Concord American Flagpole: www.concordamericanflagpole.com/#sle.
   2. Morgan-Francis Flagpoles & Accessories: www.morgan-francis.com/#sle.
   3. Pole-Tech Co, Inc: www.poletech.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FLAGPOLES

A. Flagpoles: Designed in accordance with NAAMM FP 1001
   1. Material: Aluminum.
   2. Design: Cone tapered.
   3. Mounting: Ground mounted type.
   4. Nominal Height: 20 ft; measured from nominal ground elevation.
   5. Halyard: Internal type, manual winch operation.

B. Performance Requirements:
   1. Wind Pressure Loading on Flagpole with Flag: Resistant without permanent deformation to 50 miles/hr wind speed, in accordance with NAAMM FP 1001; the factor of safety used is 2.5.

2.3 POLE MATERIALS

A. Aluminum: ASTM B241/B241M , 6063 alloy , T6 temper.

2.4 ACCESSORIES

A. Finial Ball: Aluminum, 6 inch diameter.

B. Truck Assembly: Cast aluminum; revolving, stainless steel ball bearings, non-fouling.

C. Halyard: 5/16 inch diameter nylon, braided, white.

D. Connecting Sleeve For Multiple Section Poles: Same material as pole, precision fit for field assembly of pole, concealed fasteners.

2.5 OPERATORS

A. Hand Crank: Removable type.

2.6 MOUNTING COMPONENTS

A. Foundation Tube Sleeve: AASHTO M 36, corrugated 16 gauge, 0.0598 inch steel, galvanized.

B. Pole Base Attachment: Flush; steel base with base cover.

C. Lighting Ground Rod: copper rod, {CH#69004} diameter.

D. Lightning Ground Cable: Copper No. 6 AWG, soft drawn.

2.7 FINISHING

A. Metal Surfaces in Contact With Concrete: Asphaltic paint.

B. Aluminum: Mill finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that concrete foundation is ready to receive work and dimensions are as indicated on shop drawings.

3.2 PREPARATION

A. Coat metal sleeve surfaces below grade and surfaces in contact with dissimilar materials with asphaltic paint.

3.3 INSTALLATION

A. Install flagpole , base assembly, and fittings in accordance with manufacturer's instructions.

B. Fill foundation tube sleeve with concrete specified in Section 03 30 00.

C. Install foundation plate and centering wedges for flagpoles base set in concrete base and fasten.

3.4 TOLERANCES

A. Maximum Variation From Plumb: 1 inch.

3.5 ADJUSTING

A. Adjust operating devices so that halyard and flag function smoothly.

END OF SECTION 10 75 00

SECTION 10 82 15
THROUGH WALL BOOK RETURN

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Drive up through wall book return.

B. Single through wall book return.

1.2 RELATED REQUIREMENTS

A. Section 05 12 00 - Structural Steel Framing: Mounting substrates.

B. Section 07 42 13 - Metal Wall Panels: Mounting substrates.

1.3 SUBMITTALS

A. See Section 01 33 00 Submittals, for submittal procedures.

B. Shop Drawings: Submit detailed shop drawings, indicating component profiles, sections, finishes, fastening details, special details, and manufacturer's technical and descriptive data.
   1. Include field dimensions of openings and elevations on shop drawings.
   2. Indicate distinction between factory-assembled and field-assembled work on shop drawings.

C. Warranty Documentation: Submit manufacturer warranty.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in manufacturer's original, unopened packaging, with labels clearly identifying manufacturer and material.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Kingsley www.kingsley.com

B. Substitutions: See Section 01 25 00 Substitution Proceedures

2.2 BOOK RETURN

A. Drive Up: Kingsley Ease Drive-Up ThruWall
   1. Basis of Design Product Number: 10-8175
   2. Materials:
      a. Exterior: Stainless steel faceplate, depository door flap, and built-in weather hood.
      b. Interior: Aircraft grade aluminum body including 13-inch four-sided chute housing. AirBloc neoprene rubber panel.
   3. Wording: Vinyl decal. Wording to be selected by Owner.

4. Mounting Height: ADA compliant per manufacturer's standard directions.
5. Overall Dimensions: 22"W x 25 1/8"D x 20"H

B. Walk Up: Kingsley Ease SingleDrop ThruWall
1. Basis of Design Product Number: 10-8100
2. Materials:
   a. Exterior: Heavy-duty stainless steel faceplate, depository door flap and built-in weather hood.
   b. Interior: Aircraft Aircraft grade aluminum body including 13-inch four-sided chute housing. AirBloc neoprene rubber panels.
3. Wording: Vinyl decal. Wording to be selected by Owner
4. Mounting Height: ADA compliant per manufacturer's standard directions.
5. Overall Dimensions: 22"W x 25 1/8"D x 20"H

2.3 ACCESSORIES

A. Fasteners: ASTM F593 stainless steel or ASTM A307 carbon steel, sizes to suit installation conditions.

B. Anchors and Inserts: Corrosion resistant; type, size, and material required for loading and installation as indicated.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Verify that painting, roofing, masonry work, and other adjacent work that might damage finish have been completed prior to start of installation.

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

3.2 INSTALLATION

A. Install in accordance with manufacturer's written installation instructions.

B. Set book drops level, plumb, and in alignment with adjacent work as indicated.

C. Mechanically secure book drops to supporting structure.

D. Do not cut or trim aluminum members without approval of manufacturer; do not install damaged members.

3.3 TOLERANCES

A. Maximum Variation From True Position: 1/8 inch.

B. Maximum Offset From True Alignment: 1/8 inch.

3.4 CLEANING

A. Remove temporary protective coverings as book drops are installed.

B. Clean finished surfaces as recommended by manufacturer and maintain clean condition until Date of Substantial Completion.

3.5 PROTECTION

A. Protect installed grilles to ensure grilles are without damage until Date of Substantial Completion.

END OF SECTION 10 82 15

SECTION 11 51 23
STEEL LIBRARY SHELVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A.
1. Steel-bracket shelving.

B. Related Requirements:

C. Section 06 41 13 Architectural Wood Casework for custom-fabricated library shelving, end panels, and canopy tops, display and nesting tables.

1.2 ACTION SUBMITTALS

A. Product Data:
1. Steel-bracket shelving.

B. Product Data Submittals: For each product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for library stack systems and accessories.

C. Shop Drawings:
1. Include plans, elevations, sections, and details.
2. Show clear-aisle widths from face of units.
3. Detail fabrication and installation of library stack systems, including methods of anchoring them to building structures at locations recommended by manufacturer and to meet local AHJ seismic requirements.

D. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

E. Samples for Initial Selection: For units with factory-applied finishes, 6 inches in size.

F. Samples for Verification: For the following products, one of each, in manufacturer's standard full sizes:
1. Flat shelving.
2. Each type of specialized shelving.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For library systems to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Shelf Units: Five percent of quantity installed for each size and type indicated, but no fewer than 10 units total. Note: Extra materials required are additional shelves only.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of library stack systems that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Deterioration of metal finishes and other materials beyond normal wear.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 STEEL-BRACKET SHELVING

A. Steel-Bracket Shelving: ANSI Z39.73 shelving designed for library use, consisting of two uprights and two spreaders per section forming a four-sided frame, with adjustable shelves on one or both sides of uprights cantilever-hung by brackets.

B. Manufacturers:
   1. Basis of Design: Estey www.esteyshelving.com/
   2. Spacesaver Corporation www.spacesaver.com
   3. Library Design Associates, Inc.

C. Rakks/Rangine Corporation www.rakks.com
   1. Or approved equal prior to submitting bids.

D. Bookstack Units: As indicated on drawings
   1. Type: Welded, self-supporting units
   2. Configuration: Double and Single -faced units
   3. Width: 36 inches and 32 inches
   4. Height: Varies
   5. Shelf Depth: Varies
   6. Base Support: Base shelf
      a. Base Shelf Style: Sloped Intergral Base
   7. Shelves: Provide style and number of shelves as indicated on drawings.

E. Frames:
   1. Uprights: Steel channels, 0.060 inch (1.52 mm) thick, with slots to receive shelf bracket tabs at 1 inch (25 mm) o.c.
      a. Sloped Display Frames: Where indicated, provide upright post frames with additional steel angles, 0.060 inch (1.52 mm) thick, 36 inches (914 mm) high, slotted to receive shelving and welded to frame or gusset plates at 10-degree angle to allow better

visibility of lower two shelves.

F. Spreaders: Tube steel, 0.060 inch (1.52 mm) thick.
   1. Reinforcing Gusset Plates if required: Triangular steel plates, 0.060 inch (1.52 mm) thick, with return flange along bottom edge.

G. Base Shelves: One-piece shelves, 0.048-inch- (1.22-mm-) thick cold-rolled steel sheet, designed to receive and fit snugly around uprights, with kick plate 3 inches (76 mm) high. Provide two brackets per base shelf; 0.060-inch- (1.52-mm-) thick cold-rolled steel sheet, with return flange along bottom edge. Provide perforated bases at locations where base shelves cover supply-air grilles.

H. Levelers: Adjustable pin levelers at carpeted surfaces and adjustable glides elsewhere.

I. Coordinate with End Panels and Canopies: Provide where indicated. Reference 06 41 00 Architectural Wood Casework.
   1. Veneer-Faced End Panels: 3/4 to 1 inch (19 to 25 mm) thick.
      a. Style: Flat, square top
      b. Face: High-pressure decorative laminate

J. Canopy Tops: Provide full length of each range where indicated with manufacturer's standard attachment brackets for type of top indicated.

K. Back Panels: Provide one-piece panels to divide double facing units; 0.048-inch thick cold-rolled steel sheet, with smooth finish, sized to completely fill space between uprights. At single faced units adjacent to walls, do not provide back panels.

2.2 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.3 STEEL FINISHES

A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish, consisting of prime coat and thermosetting topcoat to achieve a minimum dry film thickness of 2 mils (0.05 mm).
   1. Color and Gloss: As selected by Architect from manufacturer's full range.

2.4 ACCESSORIES

A. Floor Anchors: Galvanized steel, post-installed expansion anchors threaded concrete screws.

B. Wall Anchors: Manufacturer's standard galvanized-steel anchors.

C. Top Bracing: Minimum 1- by 1-3/4-inch (25- by 44-mm) transverse struts, 0.048-inch- (1.22-mm-) thick steel channels, welded or bolted to top of stack units and securely fastened to structure. Note: Only provide if shelving height requires additional support.

D. Filler Panels: Provide corner and intermediate wall filler panels; 0.048-inch- (1.22-mm-) thick cold-rolled steel, with fitted caps, in color and finish to match shelving. Locate where indicated to fill gaps at abutting shelving units.

E. Findable Book Supports: Wire supports
   1. Provide two per shelf.

F. Furniture Casters: Nonmarking; hooded; twin-wheel type; hidden corner bracket attachment and integral brakes.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Vacuum finished floor over which shelving is to be installed.

3.3 INSTALLATION

A. Install library shelving systems at locations indicated on Drawings and according to manufacturer's written instructions.

B. Starter/Adder Units: Connect groups together with standard fasteners according to manufacturer's written instructions, using concealed fasteners where possible.

C. Level and plumb bookstack units to a tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm).

D. Filler Panels: Install corner and intermediate wall filler panels where indicated to fill gaps at abutting shelving units.

E. Install type of shelves at locations indicated and at spacing indicated or, if not indicated, at equal spacing in each unit.

3.4 ANCHORAGE

A. Bookstack Anchorage: Install bookstacks using floor anchors, wall anchors, or top bracing in locations recommended by manufacturer and as indicated on Shop Drawings.

3.5 CLEANING AND PROTECTING

A. Repair or remove and replace defective work as directed on completion of installation.

B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

C. Protect installed products from damage during remainder of the construction period.

END OF SECTION 11 51 23

SECTION 12 36 00
COUNTERTOPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Countertops for architectural cabinet work.

B. Wall-hung counters and vanity tops.

C. Sinks molded into countertops.

1.2 RELATED REQUIREMENTS

A. Section 06 41 00 - Architectural Wood Casework.

B. Section 22 40 00 - Plumbing Fixtures: Sinks.

1.3 REFERENCE STANDARDS

A. ANSI A208.1 - American National Standard for Particleboard; 2022.

B. 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).

C. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

E. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

F. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

G. IAPMO Z124 - Plastic Plumbing Fixtures; 2022, with Editorial Revision.

H. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.

I. ISFA 3-01 - Classification and Standards for Quartz Surfacing Material; 2013.

J. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

K. NSI (DSDM) - Dimensional Stone Design Manual, Version VIII; 2016.

L. PS 1 - Structural Plywood; 2023.

1.4 SUBMITTALS

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

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Specimen warranty.

C. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.

D. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.

E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 COUNTERTOPS

A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

B. Plastic Laminate Countertops: High-pressure decorative laminate (HPDL) sheet bonded to substrate.
   1. Laminate Sheet: NEMA LD 3, Grade HGS, 0.048 inch nominal thickness.
      a. Manufacturers:
         1) Formica Corporation: www.formica.com/#sle.
         2) Basis of Design: Wilsonart: www.wilsonart.com/#sle.
         3) Nevemar.
         4) Substitutions: See Section 01 60 00 - Product Requirements.
      b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.

c. Wear Resistance: In addition to specified grade, comply with NEMA LD 3 High Wear Grade requirements for wear resistance.
d. Finish: Matte or suede, gloss rating of 5 to 20.
e. Surface Color and Pattern: As indicated on drawings.

2. Back Splashes: Same material, same construction.

C. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
1. Flat Sheet Thickness: 1/2 inch, minimum.
2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
a. Manufacturers:
1) Basis of Design: Dupont: www.corian.com/#sle.
2) Formica Corporation: www.formica.com/#sle.
3) Wilsonart: www.wilsonart.com/#sle.
4) Substitutions: See Section 01 60 00 - Product Requirements.
b. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
c. Color and Pattern: As indicated on drawings.
3. Other Components Thickness: 1/2 inch, minimum.
4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; square edge; use marine edge at sinks.
5. Back Splashes: Same sheet material, square top; minimum 4 inches high.

D. Natural Quartz and Resin Composite Countertops: Sheet or slab of natural quartz and plastic resin over continuous substrate.
1. Flat Sheet Thickness: 1-1/4 inch, minimum.
2. Natural Quartz and Resin Composite Sheets, Slabs and Castings: Complying with ISFA 3-01 and NEMA LD 3; orthophthalic polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard stone fabrication tools; no surface coating; color and pattern consistent throughout thickness.
a. Manufacturers:
1) Basis of Design: Cambria Company LLC: www.cambriausa.com/#sle.
2) Dal-Tile Corporation: www.daltile.com/#sle.
3) LG Hausys America, Inc: www.lghausysusa.com/#sle.
4) Wilsonart: www.wilsonart.com/#sle.
b. Factory fabricate components to the greatest extent practical in sizes and shapes indicated; comply with NSI (DSDM).
c. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
d. Sinks: Separate units for undercounter mounting; minimum 3/4 inch wall thickness; comply with IAPMO Z124.
e. Finish on Exposed Surfaces: Polished.
f. Color and Pattern: As indicated on drawings.
3. Other Components Thickness: 3/4 inch, minimum.
4. Back and End Splashes: Same sheet material, demi- or half-bullnose top; minimum 4 inches high.

2.2 MATERIALS

A. Wood-Based Components:
1. Wood fabricated from old growth timber is not permitted.

2. Provide sustainably harvested wood, certified or labeled; see Section 01 60 00 - Product Requirements.
3. Provide wood harvested within a 500 mile radius of the project site.
4. Wood fabricated from timber recovered from riverbeds or otherwise abandoned is permitted, unless otherwise noted, provided it is clean and free of contamination; identify source; provide lumber re-graded by an inspection service accredited by the American Lumber Standard Committee, Inc.

B. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.

C. Particleboard for Supporting Substrate: ANSI A208.1 Grade 2-M-2, 45 pcf minimum density; minimum 3/4 inch thick; join lengths using metal splines.

D. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

E. Joint Sealant: Mildew-resistant silicone sealant, white.

2.3 ACCESSORIES

A. Fixed Top-Mounted Countertop Support Brackets:
1. Material: Steel.
2. Finish: Manufacturer's standard, factory-applied, textured powder coat.
3. Color: Black.
4. Products:
   a. Centerline Brackets; Front Mounting Countertop Support: www.countertopbracket.com/#sle.

2.4 FABRICATION

A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
1. Join lengths of tops using best method recommended by manufacturer.
2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.

B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
2. Height: 4 inches, unless otherwise indicated.

C. Solid Surfacing: Fabricate tops and wall panels up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

D. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install vanities in accordance with manufacturer's instructions and approved shop drawings

B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.

C. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.

D. Seal joint between back/end splashes and vertical surfaces.

3.4 TOLERANCES

A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.

B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.

C. Field Joints: 1/8 inch wide, maximum.

3.5 CLEANING

A. Clean countertops surfaces thoroughly.

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 12 36 00

SECTION 12 93 13
BICYCLE RACKS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Outdoor bicycle racks.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Mounting surface for bicycle racks.

1.3 REFERENCE STANDARDS

A. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2022.

B. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.

C. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.

1.4 SUBMITTALS

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

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Shop Drawings: Indicate size, shape, and dimensions, including clearances from adjacent walls, doors, and obstructions.

D. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Handle racks and accessories with sufficient care to prevent scratches and other damage to the finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design:

1. Custom Bike Rack by Paris Site Furnishings and Outdoor Fitness: www.peml.com.
2. Substitutions or Alternates: Approved Equal by Architect.

2.2 BICYCLE RACKS AND ACCESSORIES

A. Outdoor Bicycle Racks: Device designed for outdoor storage of bicycles; allows user-provided lock to simultaneously secure one wheel and part of the frame on each bicycle parked or racked.
   1. Style: Custom Hollow Structural Steel Tube design; with vertical gaps for bicycle wheels and/or frames with clearance for locking mechanisms and adjacent bicycles. Rack to be approximately 14' in length and incorporate the letters "READ" as integral construction of rack utilizing 2.38" diameter HSS of .125" wall thickness Anchor plates to be integral to structure of rack and to be spaced as per manufactures recommendations.
   2. Capacity: Sized to fit area on plans.
   3. Finish: Rust preventative primer and polyester top coat Powder coat, maintenance-free and weather-resistant.
   4. Color: As selected by Architect from manufacturer's complete range. TBD.
   5. Mounting: Mounting Plate 7ga P&O Steel anchored to concrete pad/walk.

B. Materials:
   1. Tube: Stainless steel, ASTM A269/A269M, Grade TP304, seamless.
   2. Bar Round and Flat, Stainless Steel: ASTM A666, Type 304.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive bicycle racks and accessories..

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Do not begin installation until unsatisfactory substrates have been properly repaired.

3.2 PREPARATION

A. Ensure surfaces to receive bicycle racks and accessories are clean, flat, and level.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install bicycle racks level, plumb, square, and correctly located as indicated on drawings.

C. Freestanding installation: Place in location indicated on drawings.

3.4 CLEANING

A. Clean installed work to like-new condition. Do not use cleaning materials or methods that could damage finish.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 12 93 13

SECTION 22 05 01
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 ALTERNATES

A. Within the forms of their bid proposals, contractors shall state the total (labor and material) amount, (with markups), to be added to or deducted from the base bid amount for each of the alternates indicated herein or within the Bid Form or Instructions to Bidders, that the Owner may or may not decide to accept.

1.3 UNIT PRICES

A. Within the forms of their bid proposals, contractors shall state the total labor and material unit price (with markups) for each of the unit scope-of-work items that might be added or deducted on a unit-by-unit basis during the construction period of the project, that takes place before final inspection or date of acceptance review. See Bid Form or Instructions to Bidders as relates to these unit cost items.
   1. Indicate all unit costs, including controls, wiring and interlocks, as outlined and referenced within the bid form or Instruction to Bidders.

1.4 GUARANTEE

A. In entering into a contract covering this work, the Contractor accepts the Specifications and Drawings and guarantees that the work will be carried out in accordance with the requirements of the Specifications and Drawings or such authorized modifications as may be made in the Contract Documents. Contractor further guarantees that the workmanship and material will be first class and that only experienced workers, familiar with each particular class of work, will be employed. Contractor further guarantees to replace and make good at his own expense any defects due to faulty workmanship or material which may develop within one (1) year after final payment and acceptance by the Owner, upon receipt of written notification of defect from the Owner.

1.5 QUALITY ASSURANCE

A. Regulations and Standards: All equipment, apparatus, and systems are to be fabricated and installed in complete accordance with fire and insurance rules and regulations, the Life Safety Code, and the latest edition or revision of the following applicable regulations, standards, and codes:

1.	AIA	American Institute of Architects
2.	ASME	American Society of Mechanical Engineers
3.	ASTM	American Society for Testing and Materials
4.	NFPA	National Fire Protection Association
5.	NEC	National Electric Code
6.	OSHA	Occupational Safety and Health Administration
7.	UL	Underwriter's Laboratories, Inc.
8.	MCAA	Mechanical Contractors Association of America, Inc.
9.	ANSI	American National Standard Institute

10. MSSV Manufacturer's Standardization Society of the Valve and Fitting Industry
11. AWWA American Water Works Association
12. AGA American Natural Gas Association
13. PDI Plumbing and Drainage Institute
14. NACE National Association of Corrosion Engineers
15. State and Local Inspection Authorities
16. Division 01 Sections "Regulatory Requirements: and "Reference Standards" of the Project Specifications
17. References on the Drawings or in the Specifications to "code" or "building code" not otherwise identified shall mean the specific codes applicable to this Project location, together with all additions, amendments, changes, and interpretations adopted by code authorities having jurisdiction over this Project.
18. The applicable edition of all codes shall be that adopted at the time of issuance of permits by the authorities having jurisdiction and shall include all modifications and additions adopted by that jurisdiction.
19. Give all required notices so as to comply with, and meet, all inspections required by Federal, State, and Local authorities.
20. It is not the intent herewith to modify, reduce, or change any rules, standards, regulations, or requirements that are applicable under local, state, and federal codes, ordinances, or regulations of the various authorities having jurisdiction. Where the standards differ among the various authorities, the most restrictive shall apply. Where the requirements shown on the Drawings or called for in the Specifications exceed code requirements, these Drawings and Specifications shall take precedence. Where the requirements within the specifications of this division of work and the Drawings conflict with the referenced Divisions, Sections, and other documents, the documents having the most restrictive and the higher cost requirements shall apply.

1.6 JOB CONDITIONS AND COORDINATION

A. Local Conditions
   1. Each Trade Contractor is to inform himself of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work to be done.
   2. Contractors shall coordinate and review indicated utility data with the local utility companies.

B. Present Job Site Inspection
   1. Each contractor shall schedule through the Owner a visit to the present site proposed for the work before presenting a Bid and shall make a careful inspection of the existing conditions.
   2. During the site visit, each Trade Contractor is to investigate for any existing conditions and responsibilities which are not clearly defined by the Drawings and Specifications. If any such conditions exist, he/she shall bring them to the attention of the A/E in writing. The A/E will then make the required written clarification. The absence of questions before the opening of bids shall indicate a clear understanding of the scope of work and the Contractor's responsibility.

C. Concrete Housekeeping Pads and Supporting Foundations
   1. Unless otherwise specified or noted on the Drawings, the Concrete Contractor is to provide concrete pads and foundations as indicated on the Drawings for all mechanical equipment.
   2. Concrete pads as may be indicated are based upon the design and layout-based manufacturer and model of equipment and devices as specified or as scheduled or noted on the Drawings.

3. The individual Trade Contractor furnishing the equipment or devices is to verify and coordinate all concrete pad sizes so as to have same of proper size to serve the equipment or device supplied and verify the position of all anchor bolts.
4. Any additional cost for larger than indicated pad or foundation sizes to fit the approved manufacturer and model of the equipment or devices is to be borne by the Trade Contractor who supplies such equipment or devices.

D. Permits and Fees: This Contractor is to obtain all permits and pay all fees required for the work under Division 22 of the Work.

E. Royalties and Patents
1. The Trade Contractor is to pay all royalties and license fees. He/she shall defend, indemnify, and hold the Owner and A/E harmless from any and all suits, demands or claims for infringement of any patent rights.
2. The review by A/E or Owner of any method of construction, invention, appliance, process, article, device or material of any kind is to be for adequacy of work, and is not to be construed as an approval of the use thereof by the Contractor in violation of any patent or other rights of any third person.

F. Wiring and Conduit Requirements: In general, most wiring and conduit requirements are addressed, either upon the Drawings as a part of a packaged equipment assembly specifications, or within Divisions 26, 27 and 28 of the Specifications. However, should an equipment component, panel, or system device need additional wiring and conduit so as to be complete, approved and fully operational, the Contractor who supplied the equipment component, panel or system device shall be responsible for the required wiring and conduit as well as circuit disconnect and protection for same when it is not otherwise covered by the Project Drawings and Specifications.

G. Coordination: Coordinate the exact location of this work with the work of other trades prior to fabrication or installation of same. Verify all dimensions and elevations. Provide additional offsets and sections of material as may be required to meet the applicable job condition requirements. Coordinate with and review all related construction Drawings and Shop Drawings of all equipment suppliers prior to start of work.

1.7 SPECIFICATIONS AND DRAWINGS

A. These specifications and Drawings are intended to describe and provide for a complete and finished project. They are intended to be complementary. All items of work called for by either shall be as binding as if called for by both. The work described shall be complete in every detail, notwithstanding the fact that every item necessarily involved is not particularly mentioned or shown.
1. If the Bidder, Supplier or Contractor sees anything to question, it must be brought to the attention of the A/E immediately.

B. Minor Deviations: The Drawings accompanying these Specifications indicate the general design and arrangement of equipment, apparatus, fixtures, accessories and piping necessary to complete the installation of the system. The exact location or arrangement of the apparatus and equipment, unless otherwise dimensioned, is subject to minor changes necessitated by field conditions and shall be required without additional cost to the Owner. Measurements shall be verified through actual observation at the construction site. Each Trade Contractor shall be responsible for fitting all of his work into place in a satisfactory and workmanlike manner, to the approval of the A/E and Owner.

C. Provide all labor and materials necessary for the completion of the work described. Referenced codes and industry standards and methods shall apply when no other specifics are indicated.

Bring questions relating to this paragraph to the attention of the A/E for resolution prior to the receipt of Bids.

D. All Work indicated on Drawings, diagrams, or details in part only are to continue throughout unless distinctly marked otherwise. The same applies to other parts of the project where merely a typical reference plan, diagram, or section of the drawing is complete. The balance is intended to be the same as the typical plan, section, or diagram as shown and is to be figured accordingly.

E. The specifications are divided into trades and divisions only for the distinct purpose of facilitating the work. However, the Trade Contractor will become responsible for furnishing all labor and materials necessary to complete the project as contemplated by the Drawings and Specifications. Any item mentioned under any heading of the Specifications must be supplied even though it is not called for again under the heading for the respective work.

F. Should discrepancies occur within the Contract Documents, the more stringent and more costly approach shall apply for bidding purposes. The Contractor is to notify the A/E of discrepancies for clarification. Clarifications issued after the Contract is awarded shall be incorporated by the Contractor at no additional costs and shall be reviewed by the A/E to determine if a reduction in cost is justified.

1.8 TRADE CONTRACTORS, SUBCONTRACTORS AND SUPPLIERS

A. The Trade Contractor is any person or organization who contracts to perform work for the Project. Wherever the word "Contractor" is used on the Drawings or in the Specifications, it shall be construed to mean the Trade Contractor applicable to the Title Division of these specifications.

B. A Sub-Contractor is a person or organization who has a direct contract with a Trade Contractor to perform any of the Work at the site and includes all who furnish material worked to a special design in accordance with the Drawings and Specifications, but excludes suppliers or persons furnishing material not specially designed. Wherever the term "Sub-Contractor" is encountered in the Contract Documents, it shall mean the Sub-Contractor and/or his Sub-Sub-Contractors and/or his Material Suppliers.

C. A Sub-Sub-Contractor is a person or organization who has a direct or indirect contract with a Sub-Contractor to perform any of the Work at the project site or for the subject project.

D. A Material Supplier is a person or organization who has a direct contract with a Trade Contractor to furnish material not specially designed.

E. It shall be the responsibility of each Trade Contractor to be fully familiar with various local trade jurisdictional requirements and to engage the services of any other Sub-Contractors as may be required within the various trades to complete all of the work as indicated upon the Drawings and within the Specifications under his respective division or section. Only Trade Sub-Contractors with established knowledge and skills of their specific trade shall be used, so that all work is performed in a complete, finished, and professional manner.

F. Whenever any provisions of the Specifications conflict with any agreements or regulations in force among members of any Trade Associations, Unions, or Councils which regulate or distinguish what work shall or shall not be included in the work of any particular trade, the Trade Contractor shall make all necessary efforts to reconcile any such conflict without delay, damage or cost to the Owner.

G. If the progress of the work is affected by any undue delay in furnishing or installing any items of material or equipment required under the contract because of a conflict involving any such agreement or regulation, the A/E may require that other material or equipment of equal kind and quality be provided at no additional cost to the Owner.

H. Any Trade Contractor, subcontractor, or material supplier not normally employing union labor shall make all provisions necessary to avoid any resulting disputes with labor unions and shall be responsible for any delays, damages or extra cost caused by employment of such non-union labor, except as otherwise governable by state or federal rules and regulations.

I. Each Trade Contractor shall pay for all applicable Federal, State and local taxes on all materials, labor or services furnished by him, and all taxes arising out of his operations under the Contract Documents which may be imposed upon or collectable from the Owner or become a lien against his property. Such taxes shall include, but not be limited to, Occupational, Sales, Use, Excise, Social Security and Unemployment Taxes, customs duties, and all income taxes and other taxes now in force or enacted prior to final acceptance of the work. The Trade Contractor shall assume all liability for the payment of and shall pay any unemployment benefits payable under any Federal or State law to individuals employed by him during the progress of the work covered by the Contract.

J. It is the responsibility of each Trade Contractor to coordinate the various related equipment requirements between his subcontractors, suppliers, and other trade contractors, and to also follow the approved manufacturer's installation instructions.

1.9 OPERATIONAL AND MAINTENANCE INSTRUCTIONS

A. All operational and maintenance instructions that are provided to various Owner-selected members of the facility engineering and/or maintenance staff are, at the same time presented, to be fully videotaped by the Contractor so that all such sessions can be later reviewed by the Owner's staff on a retraining basis as needed. All such videotapes are to become the property of the Owner at the end of each applicable training period, with one copy of each also being supplied to the A/E for the A/E project files.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/PRODUCTS/SUBMITTALS

A. Under the Base Bid, no other manufacturers except those indicated on the Drawings or those listed within the Sections of this Division, that are, in turn, able to comply with the contract document requirements and minimum standards of these specifications, will be acceptable. In addition to specific required "Alternates," proposed substitutions that may or may not be acceptable to the Owner may be submitted by the Contractor only at the time of initial base bid submittal.

B. Although design-based models of various manufacturers may be indicated within the various schedules, it is the responsibility of the various equipment manufacturers to verify the model selections so that all items of equipment comply with the minimum standards of performance that are indicated within the schedules, as well as the requirements within various sections of the specifications under which the equipment is also specified.

C. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

D. Shop Drawings are to be submitted on each item of specified or scheduled equipment, valves, specialties, insulation, fixtures, drains, controls and related accessories. All control submittals must include a typed sequence of control for each system.

E. Coordination and Fabrication Drawings: Prepare layout drawings of all system assemblies of this Contract including plumbing, heating, sprinkler piping, electrical and technology, mechanical and electrical room layouts with equipment and piping, ductwork installations, and control systems. Include completely dimensioned plans drawn to scale. Show elevations and sections indicating locations of all equipment, piping, ductwork, drains, controls, and other items with reference to columns, walls, slabs, beams, and to components of other systems and work of other trades. Floor plans shall be drawn at not less than 1/4 inch scale with a sign-off block including all disciplines and date. Tracing or reproduction of Construction Documents is not acceptable. Provide a minimum of one reproducible drawing and five prints of each drawing.

2.2 ACCESS DOORS AND PANELS

A. Unless otherwise indicated, each Trade Contractor is to locate and furnish all access doors required for non-accessible surfaces (such as ceilings, walls, chases, and similar locations), so that all valves and similar items are easily accessible for operation, inspection, and maintenance. Access doors for ceiling, walls, chases, etc. are to be installed by the General Contractor. The Trade Contractor is to bear the costs of the installation of the access doors.

2.3 SLEEVES

A. Each Contractor is to provide properly sized, secured and firestopped sleeves for all of their piping systems at all penetrations of walls, foundations, partitions, floors and roofs throughout the entire facility.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all materials, labor, equipment, and services necessary for a complete and operable installation as specified and shown on the Drawings. The word "Provide" shall mean "Furnish and install."

B. Provide new material and equipment in strict accordance with these Specifications and the Project Drawings.

C. At all times, take such precautions as are necessary to protect materials from damage. Close all pipe openings to prevent obstructions and contamination.

3.2 CUTTING AND PATCHING IN BUILDINGS

A. Each Contractor is responsible for all costs associated with the necessary cutting and patching as required for the installation of his work, unless otherwise indicated.

B. Patching is to be performed by the trade proper for each material to be patched. Patching shall leave premises and finishes in a complete and neat condition comparable to the original. Painting of patched surfaces to be by the painting sub-contractor of the General Contractor, unless otherwise specifically indicated or the plumbing/fire protection contractor is the prime contractor for the project. Maintain the fire integrity of all walls, floors, ceilings, and partitions.

3.3 PROTECTION

A. Protect equipment and trim against damage and injury due to building materials, acid, tools, equipment and any causes incidental to construction. Cover the finished surface of each piece of equipment with building paper or similar protection. Replace all equipment damaged by any cause and any trim with marred or scratched finish at no cost to the Owner, upon receipt of written notification from the A/E.

B. Where materials to be installed are being stored at or near the project during construction, arrange such materials so as to minimize the possibility of contamination, corrosion and damage. Keep ends of pipe, equipment, and specialties properly closed during construction and installation to avoid the possibility of miscellaneous materials being placed in the openings.

3.4 PAINTING

A. See Division 09 Section "Interior Painting".

3.5 ADJUST AND CLEAN

A. Inspect all equipment and put in satisfactory working order.
   1. Clean all exposed and concealed items.
   2. Clean floor drains, cleanouts, and plumbing fixtures.
   3. Clean specialties such as traps and strainers and all equipment surfaces such as pumps, motors, etc.
   4. Clean all covers.
   5. Clean exposed piping.
   6. Adjust pumps, balancing valves, and metering faucets for proper flow rates.
   7. Adjust water heaters and thermostatic mixing valves for required temperatures.

END OF SECTION 22 05 01

SECTION 22 05 07
EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Each Trade Contractor is to provide all excavating, trenching, sheeting, bracing, pumping, and backfilling as required for the installation of their work.

1.3 QUALITY ASSURANCE

A. Testing
   1. All testing is to be done by an independent testing laboratory employed by this Contractor and approved by the Owner and A/E.
   2. Conduct up to 10 tests per Trade per 40,000 gross square foot of compacted surface serving each Trade's specific area of work to determine the compaction density of backfill.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

C. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

D. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

G. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

H. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

I. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
1. Yellow: Gas, oil, and dangerous materials.
2. Blue: Water systems.
3. Green: Sewer systems.

PART 3 - EXECUTION

3.1 GENERAL PROTECTION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

2. Remove rock to lines and grades indicated to permit installation of permanent construction.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by A/E. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract time may be authorized for rock excavation.
1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
   a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.6 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
1. Fill unauthorized excavations under other construction or utility pipe as directed by A/E.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.

5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.

D. Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under steps and ramps, use engineered fill.
   2. Under building slabs, use engineered fill.
   3. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   2. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by A/E; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 22 05 07

SECTION 22 05 13
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT MOTORS

A. Motors shall be of sufficient size for the duty to be performed and shall not exceed the motor's full-rated load when the driven equipment is operating at specified capacity under the most severe conditions likely to be encountered. Motors shall be established, U.S.-manufactured industry standard types for the service intended, having normal starting torque and low starting current characteristics, unless other characteristics are specified. When electrically driven equipment is furnished which materially differs from the contemplated design, the Contractor supplying the driving equipment shall pay for and make necessary the adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed. Motors and equipment shall meet NEMA MG1, and State and Local Energy Code minimum COP requirements. Provide suitable overload protection for each motor.

B. Unless otherwise specified or noted on the Drawings, motors shall be suitable for the service intended, shall be of latest industry standards of design for maximum energy efficiency, and shall be continuous-duty-type, as follows:
   1. Motors less than 1/2 HP shall normally be 120-volt, 1-phase, 60-HZ.

C. Coordinate and verify voltage and phase required with Electrical Drawings, as well as equipment scheduled data.

D. It shall be the responsibility of this contractor to coordinate and verify the applicable phase and voltage requirements with the electrical contractor before submittal of Shop Drawings.

2.2 MOTOR CONTROLLERS AND DISCONNECTS

A. Except as otherwise specified in each of the various sections of Division 22, motor controllers and disconnects shall be as specified under Divisions 26, 27 and 28.

B. Verify applicable voltage, phase, and protective device requirements with electrical contractor before manufacture or installation of equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall comply with manufacturer's latest published instructions and all applicable inspection and code authority requirements.

3.2 MOTOR EFFICIENCIES

A. Drip-Proof Motors

3600 RPM		*1800 RPM*	
HP	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**	**HP**	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**
1-1/2	81.0	1	84.0
2	84.0	1-1/2	84.0
3	86.0	2	84.0
5	87.0	3	88.0
7-1/2	87.0	5	88.0
10	88.0	7-1/2	90.0
15	90.0	10	90.0
20	90.0	15	91.0
25	91.0	20	91.0
30	91.0	25	93.0
40	91.0	30	93.0
50	91.0	40	93.0
60	92.0	50	94.0
75	93.0	60	94.0
100	93.0	75	94.0
		100	94.0

B. Totally Enclosed, Fan-Cooled Motors

3600 RPM		*1800 RPM*	
HP	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**	**HP**	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**
1-1/2	81.0	1	81.0
2	84.0	1-1/2	84.0
3	84.0	2	82.0
5	86.0	3	82.0
7-1/2	88.0	5	85.0

3600 RPM		*1800 RPM*	
HP	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**	**HP**	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**
10	90.0	7-1/2	87.0
15	91.0	10	89.0
20	91.0	15	91.0
25	91.0	20	92.0
30	92.0	25	92.0
40	92.0	30	93.0
50	93.0	40	93.0
60	93.0	50	94.0
75	94.0	60	94.0
100	94.0	75	94.0
125	95.0	100	95.0
150	95.0	125	95.0
200	95.0	150	95.0
		200	95.0

END OF SECTION 22 05 13

SECTION 22 05 19
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section the includes the following types of meters and gauges:
   1. Temperature gauges and fittings.
   2. Pressure gauges and fittings.

B. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 22 specifications.

1.3 QUALITY ASSURANCE

A. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.

B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

1.4 SUBMITTALS

A. Shop Drawings: Each equipment and material item specified.

B. Product Data: Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

C. Samples: Not required for review.

D. Contract Close-Out Information
   1. Maintenance data for each type of meter and gauge in each building for inclusion in Operating and Maintenance Manuals specified in Division 01, and Division 22 Section "Common Work Results for Plumbing".
   2. Portable test plug test kit and portable meter receipts as described in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Thermometers
      a. Marshalltown Instruments, Inc.
      b. Trerice (H.O.) Co.
      c. Weiss Instruments, Inc.
   2. Thermometer Wells: Same as thermometers.
      a. Insertion Dial Thermometers.

b. Ashcroft Dresser Industries/Instrument Div.
c. Trerice (H.O.) Co.
d. Weiss Instruments, Inc.

3. Pressure Gauges
   a. Ametek, U.S. Gauge Div.
   b. Ashcroft Dresser Industries/Instrument Div.
   c. Marsh Instrument Co., Unit of General Signal.
   d. Marshalltown Instruments, Inc.
   e. Trerice (H.O.) Co.
   f. Weiss Instruments, Inc.
4. Pressure Gauge Accessories: Same as for pressure gauges.
   a. Water Orifice-Type Measurement System.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett, ITT, Fluid Handling Div.
5. Test Plugs
   a. MG Piping Products Co.
   b. Peterson Equipment Co., Inc.
   c. Sisco, A Spedco, Inc. Co.
   d. Trerice (H.O.) Co.
   e. Watts Regulator Co.
   f. Flow Design, Inc.

2.2 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1% of range span or plus or minus one scale division to maximum of 1.5% of range span.
   1. Scale Range: Temperature ranges for services listed as follows:
   2. Domestic Hot Water: 30 deg to 240 deg with 2 deg scale divisions (0 deg to 115deg C with 1 deg scale divisions).
   3. Domestic Cold Water: 0 deg to 100 deg F with 2 deg scale divisions (minus 18 deg to 38 deg C with 1 deg scale divisions).

2.3 THERMOMETERS

A. Case: Die-cast, aluminum finished in baked epoxy enamel, glass front, spring-secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Red reading, organic liquid-filled magnifying lens.

D. Scale: Satin-faced, non-reflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.4 DIAL-TYPE INSERTION THERMOMETERS

A. Type: Bimetal stainless steel case and stem, 1-inch diameter dial, dust and leakproof, 1/8-inch diameter tapered-end stem with nominal length of 5 inches.

2.5 THERMOMETER WELLS

A. Brass or 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.

2.6 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube-type, bottom connection.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inch diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1% of range span.

F. Range: Conform to the following:
1. Vacuum: 30 inch Hg to 15 psi
2. All fluids: 2 times operating pressure

2.7 PRESSURE GAUGE ACCESSORIES

A. Siphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.8 TEST PLUGS

A. Test plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and two self-sealing valve-type core inserts suitable for inserting a 1/8 inch O.D. probe assembly from a dial-type thermometer or pressure gauge. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:
1. Air, Water, Oil, and Gas, 20 deg to 200 deg F (minus 7 deg to 93 deg C): Neoprene
2. Air and Water, minus 30 deg to 275 deg F (minus 35 deg to 136 deg C): EPDM

C. Ranges of pressure gauge and thermometers shall be approximately two times systems operating conditions.

PART 3 - EXECUTION

3.1 THERMOMETER INSTALLATION

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most legible position.

B. Install pressure gauges at top of hot and cold water risers.

C. Install pressure gauge at incoming water service.

D. Pressure Gauge Needle Valves: Install in piping tee with snubber.

3.3 INSTALLATION OF TEST PLUGS

A. Test Plugs: Install in piping tee where indicated, located on pipe at most legible position. Secure cap.
   1. Install test plugs adjacent to each piping point where a temperature sensing device is required by control specifications.

B. Test Kit: Provide test kit consisting of one pressure gauge, gauge adapter with probe, two bimetal dial thermometers, and carrying case. Turn over to Owner at completion of job and obtain written receipt. Forward copy of receipt to A/E as part of close-out documents.

3.4 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 22. The drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

B. Install meters and gauges piping adjacent to machine to allow servicing and maintaining of machine.

END OF SECTION 22 05 19

SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 QUALITY ASSURANCE

A. Valve Bodies, Shells and Seats: Factory-tested.

B. Standard for 125 psi and 150 psi saturated steam rated valve pressure containing parts: ASTM B62.

C. Standard for 200 psi and 300 psi valves with metallic seats: ASTM B61.

D. Iron Body Valves
   1. Pressure-Containing Parts: ASTM A126, Grade B.
   2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.
   3. Design, Workmanship, Materials, Testing: MSS-SP-70, 71.
   4. Use domestically manufactured valves where required by a Buy American Plan.

E. Butterfly Valves
   1. Face-to-Face and End-to-End Dimensions: MSS-SP-67.

F. Valve Stems: ASTM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.

G. Pressure Castings: Free of impregnating materials.

H. Manufacturer's name or trademark and working pressure stamped or cast into body.

I. 42 USC 300G: The Reduction of Lead in Drinking Water Act.

1.3 SUBMITTALS

A. Shop Drawings: Schedule indicating proposed valve for each application.

B. Product Data
   1. Manufacturer's cut sheets and/or literature.
   2. Performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
   1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
   2. Operating and maintenance manuals.

1.4 JOB CONDITIONS

A. Coordinate the exact application and location of this work with the work of other trades prior to installation within various piping systems. Verify all positions and elevations. Provide additional offsets and section of piping as required to position valves for equipment clearance and accessibility as well as system and valve operational conditions.

B. Valve manufacturer to verify indicated figure or model numbers so that selection meets required description and conditions specified. Specified data for valve shall take precedence over indicated figure or model number. Provide proper seat and seal material for applicable temperature, pressure and service indicated for each valve application.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Gate, Butterfly, Check & Ball Valves: Stockham, Nibco, Hammond, Crane, Jenkins, Powell, Milwaukee, Homestead, Apollo, Mueller, A. Y. McDonald.

2.2 DOMESTIC WATER VALVES

A. For gauge valves within steel or copper lines of 1/8 inch or 1/4 inch size, threaded or solder, 150 psig steam or 300 psig w.o.g., union bonnet, integral seat, renewable seat and disc, bronze globe valve conforming to MSS-SP-80, ASTM B-62.

B. For service valves within steel piping of 1/4 inch through 2-1/2 inch size; two-piece ball valve with bronze FNPT threaded ends, lever handle, stainless steel ball and stem, Class 150 SWP-600 w.o.g.

C. For service valves within 1/4 inch through 2 inch size copper piping, similar to above except for solder ends.

D. For service valves in copper piping 2-1/2 inch through 4 inch size; 200 psi w.o.g. butterfly valve, wafer body, suitable for dead-end and isolation service.

E. For service valves within steel piping of 3 inch or above; 200 psig w.o.g butterfly valves, installed between standard ANSI Class 125/150 flanges, suitable for dead-end and isolation service without use of downstream flanges. 3 inch through 6 inch size valves to have manual stem position, lock to prevent tampering, notched plate and latching handle while valves of 8 inch size and above shall have manual enclosed weatherproof handwheel actuators with gear box and position indicator window, and all meeting the following criteria.

	Part	Specifications
1.	Stem	Stainless Steel, ASTM A-582 Type 410
2.	Collar Bushing	Brass, ASTM B-124
3.	Stem Seal	EPDM
4.	Body Seal	EPDM
5.	Nameplate	Aluminum
6.	Upper Bushing	Copper CDA 122
7.	Liner	EPDM
8.	Disc	Al. Bronze, ASTM B-148 Alloy 954/955
9.	Lower Bushing	Copper CDA 122
10.	Body (Lug)	Ductile iron, ASTM A-536

F. For check valves within horizontal steel or copper lines through 2 inch size, bronze check valve with teflon disc, threaded ends, Class 150 swp-300 w.o.g., as follows:

	Part	Material	Specifications
1.	Body	Bronze	ASTM B62
2.	Cap	Bronze	ASTM B62
3.	Lever	Bronze	Commercial
4.	Disc	Teflon	
5.	Disc Holder	Brass	ASTM B16 1/4 inch & 1/2 inch
		Bronze	ASTM B62 3/4 inch to 2 inch incl
6.	Pin	Stainless Steel	Commercial
7.	Plug	Bronze	ASTM B16
8.	Retaining Ring	Stainless Steel	Commercial
9.	Disc Nut	Bronze	Commercial

G. Optional check valves for vertical type of installation within steel or copper lines, similar to that of above sub-paragraph G, except vertical lift up-flow, bronze with threaded ends.

H. For check valves within steel piping of 2-1/2 inch size and above, for vertical up-flow applications, Class 250 w.o.g flanged iron body flat style silent check; and for horizontal applications, Class 125 w.o.g flanged iron body horizontal swing check.

I. For check valves within copper piping of 2-1/2 inch through 4 inch size, Class 300 w.o.g bronze for horizontal or vertical installation with solder ends.

2.3 OPERATORS

A. Provide operators for valves 4 inch and larger located in mechanical spaces installed 8 feet or higher above floor.

B. Provide chain lever or chain sprocket operator with sufficient chain to reach within 5 feet of floor.

C. Remote operator accessories are to be by same manufacturer as valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with manufacturer's written instructions, and all valves must be suitable for the service intended.

B. Provide service (isolation) valve at every piece of equipment. Service valves to be positioned in a manner to allow for ease of service and removal of equipment with minimum disruption of the piping system.

C. All shut-off valves in plumbing water systems 2 inch and smaller shall be ball-type.

END OF SECTION 22 05 23

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 22 Sections "Vibration Controls for Plumbing Piping and Equipment" and "Seismic Restraint" for additional requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Pipe hanger and supports.
   2. Pipe and equipment anchors.
   3. Pipe sleeves.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

B. SMACNA.

C. NPFA

D. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, so as to maintain compliance and uniformity with SMACNA's engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

1.4 SUBMITTALS

A. Shop Drawings
   1. Miscellaneous steel layout. Indicate all point loads where miscellaneous steel is supported by structural members.
   2. Brace spacing, layout, connection method and details.

B. Product Data: Catalog cuts and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
   1. Operating and maintenance data.
   2. Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers (Non-Corrosive Environment): Elcen Metal Products Co., B-Line Systems Inc., Carpenter and Paterson Inc., Anvil.

B. Stainless Steel Pipe Hangers (Corrosive Environment): American Stainless & Supply, FM Stainless, National Pipe Hanger Corp.

C. Concrete Anchors: Phillips, Hilti.

D. Insulated Pipe Supports: Pipe Shields Inc., Anvil, Power Piping.

E. Pipe and Equipment Anchors
1. Shop-fabricated.
2. Field-fabricated.

F. Sleeves
1. Shamrock Industries, "Crete-sleeve" plastic hole forms.
2. Proset Systems Inc., "Proset" fire-safe pipe penetrations.
3. Shop for field fabricated.

G. Sleeves, Pre-Manufactured Fire and Smoke Wall Barrier: Pipe Shields, Inc., or equal.

2.2 PIPE HANGERS

A. General
1. Materials, Design and Manufacture: MSS SP-58.
2. Fabrication and Installation: MSS SP-89.
3. Selection and Application: MSS SP-69.
4. Hangers Used Directly on Copper Pipe: Copper or cadmium-plated.
5. All Other Hangers and Channels, Angles, and Supporting Steel: Cadmium-plated or galvanized, except in corrosive environment.
6. All Hanger Rods of Continuous Thread Type: Electro-galvanize or cadmium-plate after threads are cut, except in corrosive environment.
7. Galvanize all structural steel, angles, rods, channels, and hardware that are not provided with a rustproof finish, except in corrosive environment.
8. Corrosive Environment: All hangers, threaded rods, nuts, etc. to be 316 stainless steel.
9. Screw Threads on Hangers and Fittings: Conform to Class 2A and 2B of ANSI B1.1.

B. Pipe Hangers for Insulated and Bare Pipe
1. Insulated Pipe:

MSS	B-Line	ANVIL
1	B3108	260
3	B3144	295

2. Bare Pipe:

MSS	B-Line	ANVIL
1	B3100/02 C	260
3	B3144/46	295
4	B3142	216

3. Hangers for insulated pipe to be oversized to accommodate insulation, protection shields, and/or saddles.

C. Pipe Hangers in Other Situations: See MSS-SP-69.

D. Pipe Hangers on Insulated Lines
1. Pipe Sizes 2 Inch and Less: Use pipe covering shield to protect insulation.
   a. Minimum shield length: 12 inch
   b. Minimum shield thickness: 18 ga.
2. Pipe Sizes 2-1/2 Inch and Larger: Use insulated pipe supports.

E. Hanging Rollers, Cast Iron
1. MSS Type 41.
2. B-Line B3114.
3. Anvil 171.

F. Supporting Roller, Cast Iron
1. MSS Type 44, 45, or 46.
2. B-Line B3117SL, B3117, B3118SL or B3119.
3. Anvil 271, 277, or 274.

G. Insulated Pipe Supports
1. Protect all insulated pipe at point of support by 360-degree pre-insulated pipe supports.
2. Utilize 100 psi, waterproofed calcium silicate fully encased in sheet metal shield for hot pipe applications and cellular glass with ASJ vapor barrier jacket for cold pipe applications.
3. Insert same thickness as adjoining pipe insulation.
4. Use shield length and minimum sheet metal gages indicated:

Pipe Size	Shield Length	Minimum Gage
2-1/2 - 6 inch	6 inch	20
8 - 10 inch	9 inch	16
12 - 18 inch	12 inch	16
20 inch and up	18 inch	16

5. Pipe Supported on Rod Hangers: Pipe Shields, Inc., Models A1000, A2000, A3000, A4000, and A9000.
6. Pipe Supported on Flat Surfaces: Pipe Shields, Inc., Models A1000, A2000, A5000, A6000, and A7000.
7. Pipe Supported on Pipe Rolls: Pipe Shields, Inc., Models A3000, A4000, A5000, A6000, and A8000.

H. Concrete Inserts
1. Continuous Slot Inserts
   a. Anvil Power Struct PS349.
   b. B-Line Figure B32I.
2. Individual Inserts
   a. Anvil Figure 282, or 281.
   b. Do not exceed manufacturer's recommended load on any insert.

I. Beam Clamps
1. B-Line Figure B3054 or B3055.
2. Anvil Figure 133, 218, 228, 292.

J. Attachment to “Z” Type Purlin

1. PHD Figure 290.
2. Michigan No. 315.

K. Pipe Hangers for Stainless Steel Pipe
1. Split ring type or type as recommended by pipe manufacturer.
2. Hanger shall be stainless steel or have a plastic coating to protect pipe from galvanic corrosion.

2.3 PIPE SLEEVES AND SEALANTS

A. Sleeves - General
1. Sleeve all piping passing through walls, floors, roofs, foundations, footings and grade beams sufficient to allow free movement of piping.
2. Box out openings larger than 14 inch diameter.

B. Sleeves, Steel Pipes: Use in following locations:
1. Fire-rated and smoke-rated construction.
2. Structural steel members (when approved by A/E).
3. Floors: Galvanized.
4. Concrete walls.
5. Mechanical rooms, tunnels, and stairwells.
6. Polyethylene hole forms (Crete-Sleeve): Optional use in poured concrete walls and floors.

C. Sleeves for Future Work: Same as for this work.

D. Sleeves in Other Locations: As detailed. If not detailed, use 18 ga galvanized sheet metal or 24 ga spiral duct.

E. Sleeves for Plastic Piping
1. Provide pipe sleeves for all plastic-type piping (PVC, CPVC and polypropylene) at fire-rated assembly and floor slab penetrations.
2. Size sleeves per following schedule:

Pipe Size (In.)	Sleeve Size (In.)	Extension Beyond Barrier (Ft.)
1 or less	3	2
1-1/4 to 2	4	2
3	5	3
4	6	4

3. Extend sleeve listed distance beyond wall or floor on both sides.
4. Insulate plastic pipe with minimum 1 inch thick calcium silicate or 2400 deg F aluminasilica within sleeve length.

F. Sleeves, pre-manufactured fire and smoke wall barrier: Optional, similar to Pipe Shields, Inc.
1. Bare Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
2. Insulated Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
   a. Other insulated pipes: Type CS.
3. Plastic Pipe through Fire Walls and Floors: Type WFB with 1-inch-thick calcium silicate insulation encased in metal sleeve extension 2 ft. either side of fire-rated walls or floor.

G. Sleeve Sizes
1. Length: Ends flush with finished surfaces.
2. Diameter

a. Minimum 3 inch.
b. Minimum 1 inch larger than pipe and pipe insulation.
c. In concrete, 1-1/2 inch larger than pipe.
d. Diameter suitable for construction tolerances and to receive sealant, when indicated.

H. Sealants: Seal annular space around piping.
1. For fire- and smoke-rated floors, walls and partitions: Use UL-listed firestopping material that maintains fire-rated wall and floor integrity.
a. Provide proper material for each typical application as described by manufacturer.
2. Acceptable Manufacturers
a. Base
1) Dow Corning "Fire Stop".
2) Nelson "Flameseal".
3) 3M "Fire Barrier".
4) Pipe Shields Inc., Model WFB, DFB, or QDFB Series.
5) Proset Systems.
3. For Non-Rated Walls and Partitions: Use mineral or glass fiber insulation.
4. For Exterior and Foundation Walls: Use synthetic rubber seals, "Link-Seal" waterproof material or system.

PART 3 - EXECUTION

3.1 GENERAL

A. Structural Considerations
1. Steel or concrete roof/floor system, including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.
2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe Hanger Loading."
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers to bottom of concrete filled floor deck, except by permission of A/E.
5. Attach hangers to beams whenever possible.

B. Install piping systems with approved hangers and supports to prevent sagging, warping and vibration of piping systems. Install pipe hangers and supports to allow for expansion, contraction, and drainage of piping. Place hangers and supports close to valves, vertical riser drops, heavy equipment, specialties, and each piping change of direction. At first elbow of equipment run out piping risers and horizontal piping within ten (10) feet of all circulating basemounted pumps having four (4) inch or larger piping connections, shall have piping at same supported with flexible spring hangers.

C. Connect hanger rods to approved "I" beams or channel clamps, concrete inserts or expansion shields. Provide all concrete inserts and structural members required for the proper support of the piping systems with proper approved distribution of weight.

D. Do not weld to structural steel without special permission of the A/E. Do not use wooden plugs for any form of fastening.

E. Space pipe hangers for horizontal piping as indicated, unless otherwise directed. Provide pipe hangers with the minimum rod sizes shown, complete with full length machined threads, and adjusting and lock nuts.

F. Run piping substantially as shown on the Drawings. Run pipe as directly as possible, avoiding unnecessary offsets and interferences, maintaining maximum headroom and concealed in all rooms or areas, except mechanical equipment rooms, unless otherwise noted. Coordinate exact locations of mains, risers and runouts in the field with the various Trade Contractors and the A/E.

G. Arrange pipe lines to give ample room for pipe insulation. Run piping parallel to or at right angles with the lines of the building.

H. Assemble and install piping without undue strain and stress and with provision for expansion, contraction and structural settlement. Do not cut or notch structural members unless adequate provision is made with the approval of the A/E. Anchors shall be approved by the A/E before they are used.

3.2 PIPE HANGERS AND SUPPORTS

A. For standard steel and copper piping, locate hangers at each change of direction as well as within remaining lengths spaced at or within following maximum limits:

Pipe Diameter	Standard Steel Liquid	Standard Steel Vapor	Copper Liquid	Copper Vapor
1/2 inch	7 ft.	8 ft.	5 ft.	6 ft.
3/4 inch	7 ft.	9 ft.	5 ft.	7 ft.
1 inch	7 ft.	9 ft.	6 ft.	8 ft.
1-1/4 inch	7 ft.	9 ft.	7 ft.	9 ft.
1-1/2 inch	9 ft.	12 ft.	8 ft.	10 ft.
2 inch	10 ft.	13 ft.	8 ft.	11 ft.
2-1/2 inch	11 ft	14 ft.	9 ft.	13 ft.
3 inch	12 ft.	15 ft.	10 ft.	14 ft.
4 inch	14 ft.	17 ft.	12 ft,	16 ft.
6 inch	17 ft.	21 ft.	14 ft.	20 ft.
8 inch	19 ft.	24 ft.	16 ft.	23 ft.
10 inch	22 ft.	26 ft	18 ft.	25 ft.

B. For Schedule 40 or Schedule 80 PVC or CPVC piping, locate hangers at each change of direction and space at or within the following maximum limits:

	PVC or CPVC	
Pipe Diameter	Liquid	Vapor
1/2 - 1 inch	3 ft.	3 ft.
1-1/4 - 2 inch	4 ft.	4 ft.
2-1/2 - 3 inch	4 ft.	4 ft.
3-1/2 - 4 inch	4 ft.	4 ft.
5 - 8 inch	4 ft.	4 ft.

C. Provide a hanger within one (1) foot or less of each horizontal elbow and valves that are above three (3) inches in size. If spacing between horizontal elbows (or plugged tees used as elbows) is less than six (6) feet, provide only one (1) hanger located between the elbows. No hanger size or requirements shall ever be less than the minimum recommended by the Mechanical Contractor's Association of America, Inc.

D. For cast iron pressure piping, space maximum 12 feet o.c.
1. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.

E. For cast iron soil piping, space maximum 10 feet o.c.
   1. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.

F. For piping of other materials, space hangers according to manufacturer's recommendations.

G. Pipe Hanger Loading
   1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 inch	610 lb.
1/2 inch	1,130 lb.
5/8 inch	1,810 lb.
3/4 inch	2,710 lb.

   2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

H. Trapeze Hangers
   1. Suspend trapeze hangers from concrete inserts of approved structural clips.
   2. Construct trapeze hangers of galvanized angle iron, channels or other structural shapes with flat surfaces for point of support.

I. Vertical Pipe Supports
   1. Support all vertical pipe runs in pipe chases at base of riser.
   2. Support pipes for lateral movement with clamps or brackets.

J. Concrete Inserts
   1. Provide individual or continuous slot concrete inserts for use with hangers for piping and equipment exposed in finished areas, and as required.
   2. Provide concrete inserts in time for installation in concrete.

3.3 ANCHORS

A. All connections to the structure shall be sized according to actual applied load plus any seismic vertical component increase.

B. Pipe Anchors
   1. Provide as indicated and required to permit complete installation of system.
   2. Do not anchor piping to plaster or gypsum wallboard partition walls.
   3. Provide anchoring devices at locations indicated.
   4. Do not use powder driven fasteners, expansion nails, or friction spring clamps.

3.4 SLEEVES

A. Coordinate location of any opening in structural systems with A/E and other trade contractors.

B. Maintain rating of fire- and smoke-rated construction.

C. Set sleeves plumb or level, in proper position, tightly fitted into the work.

D. Set all sleeves with ends flush with finished wall and ceiling surfaces.

E. Seal around all pipes and use firestopping for all mechanical penetrations through floor slabs, fire rated walls and partitions, and at each floor level in vertical mechanical service shafts.
   1. Install firestopping as described in manufacturer's installation instructions.

F. Seal around all sleeves.

G. Fill openings made by others for piping penetrations, with same construction as work opening is in, or construction of equivalent fire or smoke rating.

3.5 MISCELLANEOUS STEEL

A. Piping Contractor (or Plumbing Contractor, as applicable) to provide all miscellaneous steel as required to accommodate pipe supports and hangers.

B. Provide Shop Drawings detailing miscellaneous steel layout and connection to structural members. Indicate all point loads where miscellaneous steel is supported by structural members.

C. All miscellaneous steel to be galvanized steel, except in corrosive environments where stainless steel shall be utilized. Repair galvanized steel at field cuts and connections.

END OF SECTION 22 05 29

SECTION 22 05 48
VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 22 Sections "Hangers and Supports for Plumbing Piping and Equipment" and "Seismic Restraint" for additional requirements

1.2 DESCRIPTION OF WORK

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the Drawings and as specified herein to provide complete vibration isolation systems in proper working order.

B. Description of Systems
1. Vibration isolators and hangers.
2. Bases and rails.
3. Isolation pads.
4. Resilient penetration sleeve/seal and lateral guides.
5. Flexible pipe connectors.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM, and AASHO standards.

B. A Practical Guide to Noise and Vibration Control for HVAC Systems, by M.E. Schaffer, and published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 30329.

C. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate equipment plan dimensions with size of housekeeping pads.

D. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.

E. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the Drawings, without claim for additional payment.

F. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

G. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

1.4 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section "Submittals".

B. Shop Drawings
   1. All equipment items specified.
   2. Spring Isolators
      a. Spring diameter.
      b. Deflection.
      c. Compressed spring height.
      d. Solid spring height.
      e. Point location of each isolator.
      f. Load at each point.
      g. Field static deflection.
      h. Horizontal loading and bolt requirements.
      i. Indicate all bases and rail clearances.
   3. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
   4. Special details necessary to convey complete understanding of the work to be performed.

C. Product Data
   1. A complete description of products to be supplied, including product data, dimension, specifications, and installation instructions.
   2. Detailed selection data for each vibration isolator supporting equipment, including:
      a. The equipment identification mark.
      b. The isolator type.
      c. The actual load.
      d. The static deflection expected under the actual load.
      e. Specified minimum static deflection.
      f. The additional deflection to solid under actual load.
      g. The ratio of spring height under actual load to spring diameter.

D. Samples: Not required for review.

E. Reference Submittals: Not required for review.

F. Contract Closeout Information
   1. Operating and maintenance data.
   2. Guarantees.

1.5 SPEED AND BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

A. Rotating mechanical equipment shall not operate at speeds in excess of 80% of their true critical speed.

B. Vertical vibration of rotating equipment shall not be greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	Vibration Displacement (MILS Peak-to-Peak)
Under 600 rpm	4
600 to 1000 rpm	3

Equipment Speed	Vibration Displacement (MILS Peak-to-Peak)
1000 to 2000 rpm	2
Over 2000 rpm	1

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sound, Vibration and Seismic Control Devices
   1. Amber/Booth Co.
   2. Korfund Dynamics Corp.
   3. Mason Industries, Inc.
   4. Peabody Noise Control Inc.
   5. Vibration Mountings & Controls, Inc.

B. Sealants for acoustical purposes as described in this section are to be one of the non-setting sealants indicated below or an approved equivalent.
   1. Acoustical sealant D.A.P.
   2. BR-96 Pecora.
   3. Acoustical sealant Tremco.
   4. Acoustical sealant U.S.G.

2.2 GENERAL

A. Provide piping and equipment isolation systems as specified and/or as indicated on Drawings.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.
   1. Provide vibration isolation equipment including mountings, hangers, structural steel bases, welded concrete pouring forms and flexible pipe connectors from a single manufacturer or vibration isolation equipment supplier.

C. Coat all vibration isolation systems exposed to moisture and an outdoor environment as follows:
   1. All steel parts to be hot-dip galvanized.
   2. All bolts to be cadmium-plated.
   3. All springs to be cadmium-plated and neoprene-coated.

D. Coordinate the requirements of this Section with those of Division 22 Section "Seismic Restraint".

2.3 VIBRATION ISOLATORS AND HANGERS

A. Equipment Mounting Isolators
   1. Type 1 Isolators: Double-deflection neoprene mountings.
      a. Minimum static deflection: 0.35 inch.
      b. Steel top plate and base plate completely embedded in color-coded neoprene stock.
      c. Friction pads both top and bottom to eliminate the need for bolting.
      d. Where bolting is required, provide bolt holes in base plate and tapped holes in top plate.
      e. Mason Industries, Type ND; or Vibration Mountings, Type RD.
   2. Type 2 Isolators: Spring-type.
      a. Free-standing and laterally stable, without any housings, snubbers, or guides.
      b. Provide 1/4-inch neoprene acoustical friction pads between baseplate and support.

c. Provide mounting with leveling bolts that must be rigidly bolted to equipment.
d. Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
e. Spring to have minimum additional travel to solid equal to 50% of rated deflection.
f. Mason Industries, Type SLF; or Vibration Mountings and Controls, Type II, Series A.

3. Type 3 Isolators: Spring-type with vertical limit stop.
   a. Equal to Type 2 isolator, except that mountings shall incorporate a resilient vertical limit stop to prevent spring extension during weight changes.
   b. Installed and operating heights to be the same.
   c. Maintain a minimum clearance of 1/2-inch around restraining bolts and between housing and spring so as not to interfere with spring action.
   d. Limit stops to be out of contact during normal operations.
   e. Mason Industries, Type SLR; or Vibration Mountings and Controls, Type AWR.
4. Type 4 Isolators: Neoprene wafer pads.
   a. Durometer or hardness to suit application.
   b. Square waffle pattern on 1/2-inch centers.
   c. Standard pads thickness: 5/16 inch; provide optional pad thickness to suit application.
   d. Provide natural rubber, hycar, butyl, silicone or other elastomers as prior approved material.
   e. Provide type "W" adhesive, both sides, for all non-bolted applications.
   f. Mason Industries, Type "W", "WMW", "WML", or "WM"; or Vibration Mountings, Type VM.

B. Vibration Hangers
1. Type 5 Isolators: Steel spring-type hanger.
   a. Steel spring and 0.3 inch deflection neoprene element in series.
   b. Neoprene element to be molded with a rod isolation bushing that passes through the hanger box.
   c. Springs to have a minimum additional travel to solid equal to 50% of rated deflection.
   d. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.
   e. Mason Industries, Type 30N; or Vibration Mountings, Type RSH.
2. Type 6 Isolators: Precompressed steel spring-type hanger.
   a. Equal to Type 5, except spring is precompressed to rated deflection, so piping or equipment are maintained at a fixed elevation during installation.
   b. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
   c. Mason Industries, Type PC30N; or Vibration Mountings, Type RSHP.
3. Type 7 Isolators: Steel spring in neoprene cup-type hanger.
   a. Steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of hanger rod.
   b. Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
   c. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring.
   d. Spring to have a minimum additional travel to solid equal to 50% of rated deflections.
   e. Provide an eye bolt on spring end and provision to attach housing to flat iron duct straps.
   f. Mason Industries, Type W30; and Vibration Mountings, Type SHP.
4. Type 8 Isolators: Double-deflection neoprene-type hanger.
   a. Minimum static deflection: 0.40 inch

b. Elements to be color-coded neoprene stock for easy identification of rated load capacity.
c. Provide hanger for direct attachment to flat iron duct straps.
d. Mason Industries, Type WHD; or Vibration Mountings and Controls, Type RHD.

2.4 BASES AND RAILS

A. Type A: Integral structural steel base.
1. Rectangular, except for equipment which may require "T" or "L"-shaped.
2. Pump Bases for Split-Case Pumps: Provide supports for suction and discharge base ells.
3. Perimeter Members: Beams with a minimum depth equal to 1/10 of the longest dimension of the base.
4. Beam depth need not exceed 14 inches, provided that deflection and misalignment are kept within acceptable limits as determined by the manufacturer.
5. Provide height-saving brackets in all mounting locations to provide a base clearance of 1 inch.
6. Mason Industries, Type WF; or Vibration Mountings and Controls, Type WFB.

B. Type B: Steel rail.
1. Provide steel members welded to height-saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base.
2. Members must be sufficiently rigid to prevent strains in the equipment.
3. Mason Industries, Type ICS; or Vibration Mountings and Controls, Type WFR.

C. Type C: Structural steel and concrete base.
1. Rectangular structural beam or channel concrete forms for floating foundations.
2. Minimum Base Depth: 1/12 of longest dimension of the base, but not less than 6 inches.
3. Base depth need not exceed 12 inches unless specially recommended by base manufacturer for mass or rigidity.
4. Bases for Split-Case Pumps: Large enough to provide support for suction and discharge base ells.
5. Provide minimum concrete reinforcement consisting of 1/2-inch bars or angles welded in place on 6-inch centers running both ways in a layer 1-1/2-inch above bottom, or additional steel as is required by structural conditions.
6. Provide steel members to hold anchor-bolt sleeves when anchor bolts fall in concrete locations.
7. Provide height-saving brackets in all mounting locations to maintain a 1-inch clearance below the base.
8. Mason Industries, Type K (Type BMK); or Vibration Mountings and Controls, Type WPF.

D. Type D: Curb-mounted base.
1. Factory-assembled isolation base that fits over roof curb and under the isolated equipment.
2. Provide extruded aluminum top member to overlap bottom member to provide water run-off independent of the seal.
3. Provide cadmium-plated springs with a 1-inch minimum deflection with 50% additional travel to solid.
4. Spring Diameter: Not less than 0.8 of spring height at rated load.
5. Provide resilient snubbers in corners with minimum clearance of 1/4-inch for wind resistance.
6. Provide a weather seal of continuous closed-cell sponge material both above and below base and a waterproof flexible ductlike EPDM connection.
7. Foam or other contact seals are not acceptable at spring cavity closure.
8. Mason Industries, Type CMAB; or Vibration Mountings and Controls, Type AXR.

2.5 ISOLATION PADS

A. Type IP1: Field-assembled for equipment mounting.
   1. Construction: 4-inch-thick, 3,000 psig, concrete pad poured over a 4-inch precompressed glass fiber isolation pad.
   2. Glass Fiber Pads
      a. Inorganic inert material with loading capacity up to 500 psig.
      b. Covered with an elastomeric coating to increase vibration dampening and to protect media.
   3. Concrete Caps
      a. 9 sq. ft. in area or less: Reinforced with 6 x 6 x 6 x 6 mesh.
      b. Larger than 9 sq. ft. in area: Reinforced with No. 4 rebar 12 inch o.c. each way.
   4. Provide concrete caps with beveled edges.

B. Type IP2: Field-assembled for equipment isolation bases.
   1. Isolation Bases: Field-assembled concrete pads provided by General Contractor. See Division 03 and structural drawings.
   2. Provide isolation bases with an isolation joint to isolate pad from floor slab. See Division 03.
   3. Make isolation bases 1 ft. larger each way than equipment mounting base or skid, and size in accordance with approved equipment shop drawings.
   4. Make isolation bases minimum 1 ft.- 2 inch thick with top of pad 4 inches above finished floor slab.
   5. Reinforce isolation bases as indicated in specifications and drawings.
   6. Type IP2 isolation pads provided by General Contractor and coordinated by mechanical work.

2.6 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals are to be field-fabricated from a pipe or sheet metal section that is 1inch larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated.

B. Sleeve to extend 1 inch beyond the penetrated construction on each side. The annular space between the sleeve and the penetrating element to be packed tightly with fire-stop-rated glass fiber or mineral wool to within 1/4 inch of the ends of the sleeve.

C. The remaining 1/4 inch space on each side is to be filled with acoustical sealant to form an airtight seal. The penetrating element is to be able to pass through the sleeve without contacting the sleeve.

D. Alternatively, prefabricated fire-rated sleeves accomplishing the same result are acceptable.

2.7 RESILIENT LATERAL GUIDES

A. These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.

B. Resilient lateral guides shall be one of the following products:
   1. Mason Industries, Type ADA.
   2. Peabody Noise Control, Type RGN.
   3. Vibration Mounting & Controls, Type MDPA.
   4. Approved equal guides (custom made) by Amber/Booth or Korfund Dynamics.

2.8 FLEXIBLE PIPE CONNECTORS

A. Spherical Rubber Connector
   1. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners, and Kevlar tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.
   2. Sizes 2-inches and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16 inches to 24 inches may be single sphere.
   3. Sizes 3/4 inch to 1-1/2 inch may have threaded two-piece bolted flange assemblies, one sphere and cable retention.
   4. Connectors shall be rated at 250 psi up to 170 deg F with a uniform drop in allowable pressure to 215 psi at 250 deg F in sizes through 14 inches. 16 inches through 24 inches single sphere minimum ratings are 180 psi at 170 deg F and 150 psi at 250 deg F. Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1.
   5. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
   6. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods.
   7. If control rods are used, they must have 1/2-inch thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi maximum on the washer area.
   8. Submit two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.
   9. All expansion joints shall be installed on the equipment side of the shut-off valves. Expansion joins shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU and Controls Rods CR as manufactured by Mason Industries, Inc. or approved equal.

B. Flexible Pipe Hoses: Type FPH, stainless-steel-type.
   1. Stainless steel braid and carbon steel fittings.
   2. Sizes 3-inch and larger: Flanged.
   3. Sizes 2-1/2-inch and less: Male nipples.
   4. Mason Industries, Type BSS; or Vibration Mountings, Type MFP.

PART 3 - EXECUTION

3.1 APPLICATION

A. General
   1. Install all vibration control equipment in accordance with manufacturer's installation instructions and as specified.
   2. All vibration control equipment shall be selected as specified and sized in accordance with weight distribution, pull or torque imposed by shop-drawing-approved equipment being isolated.
      a. Minimum static deflections may be revised subject to prior approval.
      b. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.
         1) Provide revised vibration control equipment to match revised or substituted equipment.

3. Locations of all vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.
   a. All vibration isolators to be aligned squarely above or below mounting points of the supported equipment.
   b. Isolators for equipment with bases to be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
   c. Locate isolators to provide stable support for equipment, without excess rocking. Consideration to be given to the location of the center of gravity of the system and the location and spacing of the isolators.
   d. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
   e. Hanger rods for vibration isolated support to be connected to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.
   f. Vibration isolation hanger elements to be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
   g. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Isolator deflections must be the largest determined by the provisions for pipe isolation. Do not mix isolated and non-isolated pipes on the same trapeze.
   h. No pipes or equipment are to be supported from other pipes or equipment.
   i. Resiliently isolated pipes are not to contact the building construction or other equipment.
   j. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting pipes.

B. Major Equipment
   1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on 4-inch-high concrete housekeeping pads. See architectural or structural Drawings for details.
   2. Flexible pipe connections, are to be installed at all pipe connections to vibration isolated equipment in the positions shown on the Drawings.

C. Pipes
   1. All piping within three support positions of a connection to a pump, compressor engine, or other rotating type equipment piping is to be supported by means of vibration isolation mounts, resilient pipe guides, and resilient penetration sleeve/seals.
   2. Where lateral support of pipe risers is required within the specified limits, this is to be accomplished by use of resilient lateral supports.
   3. Pipes within the specified limits (three support positions) that penetrate the building construction are to be isolated from the building structure by use of resilient penetrating sleeve/seals.
   4. Drain piping connected to vibration isolated equipment shall not contact the building structure or other non-isolated system unless it is resiliently mounted.

3.2 VIBRATION ISOLATORS

A. Use Type 1 isolators for equipment mounted on floors other than grade-supported floor slabs.
   1. Air compressors, 3 hp or less.
   2. Vacuum pumps, 3 hp or less.
   3. Minimum static deflections, 0.35 inch.

B. Use Type 2 isolators for equipment mounted on floors other than grade-supported floor slabs.

1. Air compressors, 15 hp and larger.
2. Vacuum pumps, 15 hp and larger.
3. All pumps, 30 hp and larger.
4. Minimum static deflections, 1.5 inch.

C. Use Type 3 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. All boilers.
2. Minimum static deflections, 1.5 inch.

D. Use Type 4 isolation pads for equipment mounted on grade supported floor slabs.
1. Air compressors.
2. Vacuum pumps.
3. Boilers.
4. Minimum static deflections, 0.3 inch.

E. Use Type 5 vibration hangers for suspended equipment.
1. Individual runs of piping, 3-inch and smaller.
2. In-line pumps, 2 hp and smaller.
3. Minimum static deflections, 0.3 inch.

F. Use Type 6 vibration hangers for suspended equipment.
1. Trapeze-type pipe hangers.
2. Individual runs of piping, 4 inch through 6 inch.
3. Inline pumps, 3 hp through 5 hp.
4. Minimum static deflection, 1.5 inch.

G. Use Type 6 or Type 7 vibration hangers for suspended equipment.
1. Trapeze-type pipe hangers.
2. Individual runs or piping, 8 inch and larger.
3. In-line pumps, 7-1/2 hp and larger.
4. Minimum static deflection, 2.5 inch.

3.3 BASES AND RAILS

A. Use Type C concrete platforms for equipment mounted on floors other than grade supported floor slabs.
1. Air compressors, 15 hp and larger.
2. Vacuum pumps, 15 hp and larger.
3. All base-mounted pumps, 30 hp and larger.

3.4 ISOLATION PADS

A. Use Type IP1 isolation pads for equipment mounted on floors other than grade-supported floor slabs.
1. Air compressors, 5 hp through 10 hp.
2. Vacuum pumps, 5 hp through 10 hp.
3. All base-mounted pumps, 25 hp and less.

B. Use Type IP2 isolation pads for equipment mounted on grade.
1. Boilers.
2. Pump groups where one pad serves two or more pumps.

3.5 FLEXIBLE PIPE CONNECTIONS

A. Use Type FPC flexible connectors in piping systems.

1. Pump Suction and Discharge
   a. Exception: When two or more mechanical grooved pipe (Victaulic type) couplings are used at each pump suction or discharge side.
2. Building expansion joints.

B. Use Type FPH flexible hose in piping systems.
1. Air compressor discharge piping.
2. Vacuum pump suction piping.
3. Fuel oil pump suction and discharge piping.

C. Install flexible pipe connections and flexible hoses on equipment side of equipment isolation valves.

D. Provide flexible connectors and flexible hose to suit the application.
1. Indicate specific applications on shop drawings.

3.6 HORIZONTAL PIPE ISOLATION

A. First three pipe hangers in the main lines near mechanical equipment shall be Type 8 isolators.

B. Horizontal runs in all other locations throughout the building shall be isolated by Type 7 isolators.

C. Floor supported piping shall rest on Type 3 isolators.

D. All Type 7 isolators, or the first three Type 8 mounts, as noted above, will have same static deflection as specified for the mountings under the connected equipment.

E. If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75 inch deflection for pipe sizes up to and including 3 inch; 1.5 inch deflection for pipe sizes up to and including 6 inch; and 2.5 inch deflection thereafter.

F. All other hangers and mounts will have a minimum steel spring deflection of 0.75 inch.

G. Locate hanger as close to overhead supports as is practical.

END OF SECTION 22 05 48

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Piping identification.
   2. Valve identification.
   3. Equipment identification.

1.3 QUALITY ASSURANCE

A. Piping System Identification: ANSI A13.1-2015, "Scheme for the Identification of Piping Systems."

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Manufacturer's cut sheets and/or literature.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Valve chart showing valve numbers, type, and location.

PART 2 - PRODUCTS

2.1 PIPE MARKERS

A. Conform to ANSI A13.1-2015.
   1. Pressure-sensitive vinyl (self-sticking) material.
   2. Mechanically Fastened Type: Snap-on or strap-on.
      a. For dirty greasy, oily pipe where pressure-sensitive markers may not perform satisfactorily.
   3. Provide with direction of flow arrows.

4. Size of Letters Legend

Outside Diameter of Pipe or Pipe Covering	Length of Color Field	Size of Letters and Arrows
3/4 to 1-1/4 inch	8 inch	1/2 inch
1-1/2 to 2 inch	8 inch	3/4 inch
2-1/2 to 6 inch	12 inch	1-1/4 inch
8 to 10 inch	24 inch	2-1/2 inch
Over 10 inch	32 inch	3-1/2 inch

2.2 VALVE TAGS

A. Brass or Anodized Aluminum Type
   1. Brass: Minimum 19 ga, polished, 1-1/2-inch diameter with following lettering:
      a. Service: 1/4 inch stamped black filled letters.
      b. Valve numbers: 1/2 inch stamped black filled letters.
   2. Aluminum: 2-inch diameter, 0.032 inch thick, with following lettering:
      a. Service: 1/4 inch engraved letters.
      b. Valve numbers: 1/2 inch engraved letters.

B. Valve Tag Fasteners: 4-ply 0.018 copper or monel wire meter seals, brass "S" hooks or No. 16 brass jack chain.

2.3 EQUIPMENT NAME PLATES

A. 1/16-inch rigid plastic "Setonply," "Emedolite," or bakelite with 4 edges beveled, or engraved aluminum with black enamel background and natural aluminum border and letters.
   1. Two 3/8-inch mounting holes.
   2. Lettering size: Minimum 1/2-inch high.
   3. Fasteners: Commercial quality, rust-resisting nuts and bolts with backwashers and self-tapping screws or rivets.

2.4 CHART AND DIAGRAM FRAMES

A. Extruded aluminum with plexiglass or glass windows.

2.5 ACCEPTABLE MANUFACTURERS

A. Pipe, Valve, and Equipment Markers
   1. Craftmark Identification Systems.
   2. W. H. Brady Co.
   3. EMED Company, Inc.
   4. Kolbi Industries, Inc.
   5. 3M Co.
   6. Seton Name Plate Corp.

PART 3 - EXECUTION

3.1 VALVE AND EQUIPMENT IDENTIFICATION

A. Designate all equipment and valves by distinguishing numbers and letters on charts and/or diagrams.
   1. Tag and locate following equipment items:
      a. Valves.
      b. All items indicated on drawing equipment schedules.

B. Install tags on all devices with numbers and letters corresponding to charts.

C. Fasten tags securely to devices with tag fasteners in manner for easy reading.

D. Attach equipment nameplates in conspicuous location on item of equipment or apparatus such as starters, pumps, and control panels.
   1. Secure nameplates with self-tapping screws, or nuts and bolts.

E. For unsuitable conditions, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

F. Furnish 4 charts including device number, location (room number, department) and purpose.
   1. Mount 1 chart in frame and secure on wall in location directed by Owner.
   2. Include remaining 3 sets in "Operation and Maintenance Manuals."

G. Provide all devices located above ceilings with additional identification.
   1. Use access panel markers (metal-tack-style) for acoustical tile ceilings, or engraved plastic style, 3/4 inch square, for mounting on panel door.
   2. Coordinate with Owner on identification method and color codes.

3.2 PIPE IDENTIFICATION

A. Soil, waste, and vent piping do not require color coded paint or bands.

B. Locate pipe markers as follows:
   1. Next to each valve and fitting, except on plumbing fixtures and equipment.
   2. At each branch or riser take-off.
   3. At each passage through walls, floors, and ceilings.
   4. At each pipe passage to underground.
   5. On all horizontal pipe runs every 20 ft., at least once in each room and each story traversed by piping system.
   6. Identify piping contents, flow direction, supply and return.

C. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.3 SERVICE ABBREVIATIONS

A. General
   1. DCW Domestic Cold Water
   2. DHW Domestic Hot Water Supply
   3. DHWR Domestic Hot Water Recirculating

END OF SECTION 22 05 53

SECTION 22 05 61
PREPARATION OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CLEANING AND PREPARATION FOR SERVICE

A. Flushing Mains. Immediately upon completion of the water distribution system, test valves to ensure their full opening. Flush the system as follows: Open valve and permit the flow to continue until the water runs clear. Repeat the operation at the next valve and proceed in order to the valve farthest from the source of supply. Use outlets in building to flush the upper ends of mains and service lines. During such flushing operation, the A/E may test the flows from valves and, before final acceptance of the work, make further tests of flows to ascertain that lines are clear.

B. Interior and Exterior Sterilization of Water Distribution System. After the water distribution system has been flushed, sterilize the system by the following or other, more rigid methods satisfactory to the A/E and the State and Local Plumbing Authorities.
   1. Introduce chlorine or a solution of calcium or sodium hypochlorite, filling the lines slowly and applying the sterilizing agent at a rate of 50 parts per million of chlorine, as determined by residual chlorine tests at the ends of the lines. Open and close all valves and hydrants while chlorinating the system.
   2. After sterilization agent has been applied for 24 hours, test for residual chlorine at the ends of the lines. If less than 25 ppm is indicated, repeat the sterilization process.
   3. When tests show at least 25 ppm of residual chlorine, flush the system until all traces of the chemical are removed.

C. The Owner reserves the right to require testing of the water again at any time prior to final acceptance of the work and, if found bacteriologically unsafe, to require the Contractor to rechlorinate the system until the water is proven equal to that supplied by the public system.

3.2 SANITARY WASTE AND VENT SYSTEMS

A. Test systems as recommended by Local and State Plumbing Inspection Authorities.

3.3 OPERATIONAL TEST

A. Upon completion of and prior to acceptance of the installation, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:
   1. Time, date, and duration of test.
   2. Water pressure at the most remote and the highest fixtures.

3. Operation of each fixture and fixture trim.
4. Operation of each valve, hydrant, and faucet.
5. Pump suction and discharge pressures.
6. Temperature of each domestic hot water supply.
7. Operation of each floor and roof drain by flooding with water.
8. Operation of each vacuum breaker and backflow preventer.
9. Complete operation of each water pressure booster system (when applicable), including pump start pressure and stop pressure.

END OF SECTION 22 05 61

SECTION 22 05 93
PLUMBING SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work Includes
   1. Furnishing all labor, materials, tools, equipment, and services to test, balance and adjust all mechanical systems as indicated, in accord with provisions of Contract Documents.
   2. Complete coordination with work of all other trades.

B. Test, balance, and adjust following mechanical systems:
   1. Domestic Circulating water systems, Hot Water.

1.3 QUALITY ASSURANCE

A. Agency Qualifications: Independent balance and testing agency, member of the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

B. Balancing Standards: AABC requirements and recommendations.

1.4 RESPONSIBILITIES OF TESTING AND BALANCING AGENCY WORK

A. Schedule work with trades involved.

B. Check, adjust, and balance system components to obtain optimum conditions for function and operation of system.

C. Evaluate operation of systems and advise installer of necessary adjustments and corrective measures.

D. Balance to within plus or minus 10% of set point of balancing valves or pumps.

E. Prepare and submit test reports.

1.5 RESPONSIBILITIES OF PLUMBING CONTRACTOR'S WORK

A. Startup systems and keep in correct operation during balancing operations.

B. Clean strainers prior to balancing system.

C. Make personnel accessible to provide necessary adjustments and corrections to systems as directed by balancing agency.

D. Maintain accessibility to test locations and devices requiring adjustment.

E. Provide to the Test and Balance Agency a complete set of approved Shop Drawings and submittals and a posted set of Plumbing Drawings, indicating any and all changes to the Contract Documents.

1.6 JOB CONDITIONS

A. Balance at time directed by Owner.

1.7 GUARANTEE

A. Provide extended warranty of 90 days, after completion of test and balance work, during which time the CM/Owner may, at their discretion, request recheck or resetting of any equipment or system which is not performing satisfactorily. Provide technicians to assist as required in making such tests.

1.8 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Not required for review.

C. Samples: Not required for review.

D. Reference Submittals: Qualifications of balancing agency and sample report forms.

E. Contract Closeout Information
   1. Balancing Reports
      a. Use forms similar to AABC latest edition.
      b. Report to include the following:
         1) All specified data including balancing valve location and gpm.
         2) All equipment nameplate information.
         3) AABC equipment data sheets.
         4) Pump curves.
         5) Temperature readings leaving water heater or thermostatic mixing valve and at recirculation pump.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Accurately calibrate and maintain all test instruments in good working order.
   1. If requested, conduct tests of instruments in presence of Owner.

B. If requested, conduct balancing tests in presence of Owner.

C. Do not begin balancing until system(s) have been completed and are in good working order.

D. Record all inspections, tests, and adjustments.

3.2 WATER BALANCE PROCEDURE

A. Open all valves to full open position.

B. Checks pump rotation.

C. Check expansion tanks to determine they are not air-bound.

D. Check for installation and proper operation of manual air vents.

E. Check hot water supply temperatures and return water temperatures at mains. Reset to correct design temperatures.

F. After completing balancing valve to set points noted on drawings, test hot water pressures and flows at the pumps and re-adjust if required.

G. Check the following in domestic hot water systems.
1. Leaving water temperature at water heater.
2. Leaving water temperature at thermostatic mixing valve.
3. Pressure of domestic cold water at water service entrance.
4. Pump operating suction and discharge pressures and final total dynamic head.
5. Water metering device readings.

H. List all mechanical specifications of pumps.

I. Record nameplate and actual operating amperages of pump motor.

3.3 SPARE PARTS

A. Provide portable readout kit and specific manufacturer's balancing wheel (charts) for Owner's use.

3.4 OPERATING TEST

A. After systems are balanced, conduct operating test of not less than 8 hours' duration for the domestic hot water systems to demonstrate to satisfaction of the Owner that systems comply with requirements of plans and specifications, and that all equipment and controls are functioning properly.

END OF SECTION 22 05 93

SECTION 22 07 00
PLUMBING INSULATION

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to;
   1. Pipe insulation.
   2. Equipment insulation.
   3. Insulation adhesives, mastics and caulking.

B. Definitions
   1. Concealed Insulated Surfaces: Piping and equipment in walls, partitions, floors, pipe chases, pipe shafts, duct shafts, sealed alleyways, and above suspended ceilings.
   2. Exposed Insulated Surfaces: Piping and equipment located in mechanical rooms, tunnels, and rooms without suspended ceilings.

1.3 QUALITY ASSURANCE

A. Comply with fire and smoke hazard ratings indicated.
   1. Test by procedure ASTM E84, NFPA 255, and UL 723.
   2. Accessories such as adhesives, mastics, cements, tapes, and glass fabric, same or better component ratings.
   3. Following are rating requirements:
      a. Flame spread (maximum): 25
      b. Smoke developed (maximum): 50
   4. Properly identify products and/or their shipping cartons for flame and smoke ratings.
   5. Where prohibited by code or local ordinances, do not use elastomeric-type insulation anywhere within ceiling plenum return air systems.

1.4 SUBMITTALS

A. Shop Drawings: Submit schedule indicating service, application, thickness and finishes.

B. Product Data
   1. Manufacturer's cut sheets and literature.
   2. Performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Close-Out Information
   1. Manufacturer's installation, maintenance, and painting data.
   2. Guarantees.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Glass Fiber Pipe Covering, Calcium Silicate, and Thermal Insulating Wool: Manville, Owens-Corning, Manson, Knauf.

B. Fire-Retardant Adhesive: Manville, Benjamin Foster, 3M, Insul-Coustic, Childers.

C. Lagging Adhesive: Manville, Benjamin Foster, Borden, Insul-Coustic.

D. Elastomeric Pipe Insulation and Equipment Covering: Armstrong Armaflex, IMCOA, Imcolock, Ultrafoam.

E. Insulated Fitting Covers: Manville, Certain-Teed, Knauf.

F. Insulation Caulking: Dow No. 11.

2.2 GENERAL

A. Provide fire and smoke hazard ratings as indicated for entire composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation).

B. Do not use material that exceeds specified flame and smoke ratings.

C. Use permanent treatments to jackets or facings to impart specified fire ratings.

D. Use of water soluble treatments is prohibited.

E. At Hangers and Bracing: See Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment".

2.3 PIPE INSULATION, NON-FLEXIBLE

A. Pipe Insulation, Non-flexible
1. O-C fiberglas ASJ/SSL-II pipe insulation with all service jacket (ASJ).
2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75 deg F.
3. Apply to the following piping in thickness indicated:
   a. (Domestic) potable & non-potable cold water:
      1) Runouts to fixture (<12 feet).....1/2 inch
      2) 1-1/4 inch and smaller.....1/2 inch
      3) 1-1/2 and larger.....1 inch
   b. Domestic hot/recirculating water (thru 140 deg F):
      1) 1-1/4 inch and smaller..... 1 inch
      2) 1-1/2 inch and larger.....1-1/2 inch

2.4 PIPE INSULATION, FLEXIBLE

A. Pipe Insulation, Flexible
1. Armstrong self-seal AP Armaflex flexible elastomeric pipe insulation.
2. Thermal conductivity (K value): Not greater than 0.27 at mean temperature of 75 deg F.
3. Apply to following piping in thickness indicated:
   a. Domestic (potable) cold water:
      1) 2 inch and smaller.....1/2 inch
   b. Waste piping from water coolers and drinking fountains:
      1) All sizes.....1/2 inch

2.5 INSULATION FOR HOT EQUIPMENT

A. Insulation For Hot Equipment (Domestic Water Systems)
   1. O-C Type 703 fiberglass board, 3.0 pcf, FRK facing.
   2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75 deg F.

2.6 INSULATION FOR DOMESTIC WATER HEATER STORAGE TANKS

A. Insulation for Domestic Water Heater Storage Tanks
   1. O-C Type 703 fiberglass board, 2 inch thickness, 3.0 pcf density, unfaced.
   2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75deg F.
   3. Apply to all domestic water heater storage tanks, except when specified as factory-insulated.

2.7 INSULATION FOR COLD EQUIPMENT

A. Insulation for Cold Equipment
   1. Armstrong Armaflex II sheet insulation; 1-1/2 inch material installed in 2 layers with joints staggered.
   2. Thermal conductivity (K value): Not greater than 0.27 at mean temperature of 75 deg F.

2.8 INSULATION FASTENERS

A. Insulation Adhesive: Childers CP-82.

B. Insulation Mastic: Childers CP-30.

C. Insulation Caulking: Dow No. 11.

PART 3 - EXECUTION

3.1 APPLICATION - GENERAL

A. Do not insulate piping until satisfactory completion of required pressure tests.

B. Do not insulate heat-traced piping until cable installation is complete and a megohmeter test has been passed.

C. Apply insulation to clean, dry surfaces with pipe surfaces at room temperature.

D. Butt insulation firmly together with longitudinal and end joints sealed with compatible jackets, facings and adhesives as specified.

E. Apply adhesives, mastics and coatings per manufacturer's recommendations and as specified.

F. On cold surfaces where vapor barrier jackets are used, apply insulation with a continuous, unbroken vapor seal.
   1. Adequately insulate and vapor seal hangers, supports, and anchors that are secured directly to cold surfaces to prevent condensation.

G. Continue insulation through sleeves and wall and ceiling openings except insulation shall not continue through fire-rated (2-hour or greater) partitions, walls, floor-ceiling systems.

H. Insulate all fittings, valve bodies, flanges and other pipeline accessories.

I. At hangers and bracing, install in accord with Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment".

J. Contractors shall consult manufacturer's Technical Bulletins for detailed information on safety precautions in using all insulation products, polyurethanes, polyisocyanurates, and related materials. The data shall describe fire and other risks, safety in handling, toxicity, threshold limit values, physiological effects of inhalation and eye and skin contact, incompatibilities and other essential information regarding use. Obtain six (6) copies for distribution and use at jobsite and for submittal with shop drawing submittals.

3.2 APPLICATION OF NON-FLEXIBLE PIPE INSULATION

A. On piping, install with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge on hot piping.
   1. On cold piping, use self-sealing lap system or adhesive applied to both surfaces per manufacturer's recommendation.
   2. Do not staple cold piping.
   3. Butt adjoining sections of insulation tightly together and continue jacket by installing self-adhering butt strips over entire circumferential joint.

B. Installation of Insulation of Fittings
   1. For pipe sizes 2 inches and smaller, finish with mineral fiber cement to thickness of adjoining pipe insulation.
   2. Over 2 inches, insulate with mitered pipe insulation segments or preformed fiberglass fittings secured with vinyl faced insulation strapping tape or 20 ga galvanized annealed wire and finished with one coat of mineral fiber cement.
   3. After cement is dry, finish with Glass Fab and seal with Foster 30-36 adhesive.
   4. Prefabricated fitting covers approved for use at pipe fittings may be used instead of finishing method outlined above.
   5. Install in accordance with manufacturer's recommendations.

C. Cover all insulated piping exposed to weather with additional jacket of 0.016-inch smooth aluminum with moisture barrier.
   1. Apply aluminum jacket with 0.020-inch x 3/8-inch aluminum bands on 9-inch centers, minimum 2-inch lap joint.
   2. Protect fittings, valves, and specialties exposed to weather in like manner.
   3. Contractor option: Use Ceel-Co 300 Series plastic jacketing applied per manufacturer's recommendations.

D. Reinforce jackets on insulated piping in mechanical rooms and central plant less than 8 ft. above floor.
   1. Cover with 0.030 inch PVC jacket conforming to 25-50 fire requirements.

3.3 APPLICATION OF FLEXIBLE PIPE INSULATION

A. Install tubing wherever possible by slipping material over piping. Otherwise, slit pipe insulation, tightly butt ends and seal butt joints and slit seams with suitable adhesive.

B. Insulate fittings and valve bodies with segments cut from pipe insulation. Apply with adhesive.

C. Insulate piping at hanger points with fiberglass material protected with metal saddles.

3.4 APPLICATION OF INSULATION ON HOT EQUIPMENT

A. Install insulation with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge.

B. Butt adjoining sections of insulating tightly together and continue jacket by installing self-adhering butt strips over entire joint.

C. Insulate flanges and fittings with mineral fiber cement.

D. Finish body with 0.016-inch aluminum jacket. Reinforce end and irregular surfaces with Glass Fab embedded in 2 coats of Foster 30-36 adhesive.

3.5 APPLICATION OF INSULATION ON DOMESTIC WATER HEATER STORAGE TANKS WHEN TANKS NOT FACTORY-INSULATED

A. Install insulation with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge.

B. Butt adjoining sections of insulating tightly together and continue jacket by installing self-adhering butt strips over entire joint.

C. Insulate flanges and fittings with mineral fiber cement.

D. Finish body with 0.016-inch aluminum jacket. Reinforce end and irregular surfaces with Glass Fab embedded in 2 coats of Foster 30-36 adhesive.

3.6 APPLICATION OF INSULATION ON COLD EQUIPMENT

A. Apply with Armstrong 520 adhesive covering entire surface as well as back of insulation.

B. Coat all butt edges and press firmly together with 1/8-inch overlay pressure.

C. Apply two (2) coats of Armstrong Armaflex finish over sheet surfaces.

END OF SECTION 22 07 00

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. This Section applies to potable cold water, hot water, and hot water recirculation piping.

1.3 EQUIPMENT BY OTHERS

A. Include all necessary roughing-in and final equipment connections by plumbing trade as required.

B. Wherever equipment is furnished and set in place under Work of another Section or by Owner, they shall furnish detailed Drawings and exact rough-in dimensions and locations at the Site.
   1. Information shall be furnished sufficiently in advance to allow proper installation of all required services.
   2. If the Owner does not provide information sufficiently in advance, the Owner shall provide compensation for additional costs incurred due to changes in location of required services.
   3. This Division shall include all required service rough-ins and final connections to the equipment.

1.4 QUALITY ASSURANCE

A. General
   1. Provide all supervision, labor, tools, materials, equipment, accessories, and specialties necessary to completely install, clean and test the plumbing systems.
   2. All materials shall be free from defects impairing strength and durability and shall be of the best quality for the indicated purposes. All Work shall have structural properties sufficient to solely sustain or withstand strain and stresses to which it is normally subjected; all Work shall be true to detail.

B. Codes and Standards (Division 22 Section "Common Work Results for Plumbing" Listings and the following).
   1. Plumbing installation shall be in accordance with the state and local plumbing code, and all other codes having jurisdiction.
   2. American Standard Code for Pressure Piping ANSI B31.1
   3. National Association of Corrosion Engineers
   4. American National Standards Institute (ANSI)
   5. American Society of Mechanical Engineers (ASME)
   6. American Society for Testing and Materials (ASTM)
   7. American Water Works Association
   8. Manufacturer's Standardization Society of the Valve and Fitting Industry
   9. Plumbing and Drainage Institute
   10. State or local Plumbing Code, as applicable.
   11. State or local Building Code, as applicable.

12. 42 USC 300G: The Reduction of Lead In Drinking Water Act.

C. Material Standards
1. ASTM B32-04: Specification for Solder, Metal Sizes.
2. ASTM B42-02: Specification for Seamless Copper Pipe, Standard Size.
3. ASTM B75-02: Specification for Seamless Copper Tube.
4. ASTM B88-03: Specification for Seamless Copper Water Tube.
5. ASTM B251-02: Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
6. ASTM B302-02: Specification for Threadless Copper Pipe.
7. ASTM A53-04a: Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.
8. AWWA C651-05: Standard for Disinfecting Water Mains.

1.5 SUBMITTALS

A. Shop Drawings
1. Piping Systems: Submit piping layout drawings for domestic cold water, hot water, and hot water recirculation piping systems prior to installation.

B. Product Data: Catalog cuts.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Valve Chart (See Division 22 Section "General Duty Valves for Plumbing Piping")
a. Prepare valve chart for review prior to installation.
2. Test reports.
3. Final approvals by authorities having jurisdiction.

1.6 HANDLING, DELIVERY, AND STORAGE

A. General
1. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.
2. No extra cost shall be charged the Owner for handling, delivery, or storage.
3. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.

1.7 JOB CONDITIONS

A. Coordinate the exact location of this work with the work of other trades prior to fabrication and installation. Verify all dimensions and elevations. Provide additional offsets and section of piping as required to meet job conditions. Coordinate with and review all related Drawings of all trades prior to start of work.

B. All uninsulated piping and fittings exposed to public view in kitchen and servery shall be chrome-plated or stainless steel. All piping and fittings in kitchen not exposed to public view shall be chrome-plated or painted with a high-temperature aluminum paint.

PART 2 - PRODUCTS

2.1 PIPING

A. General
1. The outside of all piping and fittings shall bear the Manufacturer's standard marking for type, pressure, etc.
2. The A/E does not guarantee the accuracy of the figure numbers as listed.
3. Use copper piping for domestic (potable) water system piping, except where noted on the Drawings to use CPVC piping.

B. Pipe - General
1. All pipe and fittings shall be equal to or better than the grade specified.
2. All piping material shall be new and free from defects and shall be subject to standard mill test before being shipped.
3. Pipe shall be labeled.
4. Fittings and valves shall have the Manufacturer's name or trademark legibly raised or cut into each piece.
5. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
6. No salvaged or used pipe shall be used without the written approval of the A/E or Owner. Wherever such approval is given, recut the ends of the pipe, square, cut new threads on screwed pipe, and thoroughly clean the pipe of all rust, dirt, scale and foreign matter before installation.

C. Pipe 4-inch Size and Smaller
1. Pipe: Copper tube, seamless, type L hard temper, ASTM B-88, above ground, and type K soft temper, 2-inch and smaller, below ground.
    a. Fittings: Cast brass or wrought copper, solder type, ASTM 75, ANSI B16.22, or B16.18.
    b. Joints: Soldered, 95-5 tin-antimony solder above ground, and silver solder below ground.
    c. Unions: Sweat-end, 150 lb. cast brass, ground joint.
    d. Mechanically formed tee connections and couplings, such as T-drill, are acceptable. All joints shall be brazed with brazing material conforming to AWS A5.8 Classification BCUP-3 or BCUP-4.
    e. For 2-1/2-inch through 4-inch Type L copper piping above ground, the use of a grooved piping system including couplings, reducers, elbows, tees, and flange adaptors that are certified and approved by BOCA, IAMPMO, SBCCI, and UL for up to 300 psig working pressure and up to 230 deg F operating temperature is acceptable. All copper piping to be roll grooved.

D. Pipe and Fittings 3-inch and Larger (Underground)
1. Ductile Iron Pipe
    a. Pipe: Conform to AWWA C151.
    b. Cement-mortar lining: Conform to AWWA C104.
    c. Protective coating outside: Bitumastic or coal tar enamel.
    d. Thickness class: 53.
    e. Pressure class: 350 psi
    f. Joints: Mechanical or push-on, conform to AWWA C111.
    g. Fittings
        1) Gray iron or ductile iron
            a) Full-body: Conform to AWWA C110, or
            b) Compact: Conform to AWWA C153.
        2) Class
            a) 250 or 350 up to 24-inch diameter.
        3) Bituminous coating: Inside and outside.
        4) Cement lining: Conform to AWWA C104.
            a) Polyethylene encasement.

5) Conform to AWWA C105.
6) Thickness: 8 mil.

2.2 PIPING AUXILIARIES/SPECIALTIES

A. General: All auxiliaries and specialties shall be guaranteed by the manufacturer for the pressure, temperature and materials being handled. All auxiliaries and specialties shall be suitable for the piping to which they are attached.

B. Strainers
1. Manufacturers: Sarco, Anderson, Armstrong, Crane, or Watts.
2. Sarco type BT or BF-150, bronze body with stainless steel screen. Provide drain valve on strainer.

C. Water Hammer Arresters
1. Manufacturers: Josam, Mifab, Wade, J.R. Smith, Watts, or Zurn.
2. Josam type "Absorbatron".
3. Meet the requirements of PDI Standard WH-201 for size and location.
4. Size of unit shall be clearly indicated on unit.

D. Vacuum Breakers and Dual Checks
1. Manufacturers: Watts, Chicago Faucet, Febco, Wilkins, Conbraco, or Woodford.
2. Hose Connections: ASSE 1011, Watts #8A, 3/4-inch hose thread. (#8AC in finished areas).
3. Ice Machines: ASSE 1024, Watts Series 7 with two chrome nickel plated brass replaceable dual checks for 3/8 inch thru 1 inch size.
4. Coffee Maker: ASSE 1022, Watts SD-3 with stainless steel body, dual checks, wye strainer and drain port for 1/4 inch through 3/8 inch size. Pipe drain port to drain and terminate with air gap.

E. Trap Seal Protection Devices
1. Subject to compliance with requirements, provide SureSeal Manufacturing; Inline Floor Drain Trap Sealer or approved equal.
2. Standard: ASSE 1072-2007
3. Body: ASB Plastic
4. Diaphragm & Sealing Gasket: Neoprene Rubber
5. Size: 2 inch (50 mm), 3 inch (75 mm), 4 inch (100 mm).
6. Gravity Drain Outlet Connection: Compression fit sealing gasket 80 durometer.

F. Drain Valves: Powell 502-HS with cap and chain, or equal by Hammond, Keystone, or Watts.

G. Gauge Cocks: Powell Fig. 757, or equal by Anvil, Waltec, Victaulic, White Rogers.

H. Hot Water Balancing Valves.
1. Manufacturers: Sarco W-SS-6, Flow Design Model (FDI) Model UA, Griswold or Tour Anderson (TA) Combination Balancing/Shut-Off.
2. Manual throttling venturi with union, chrome-plated ball, teflon seats, blowout-proof stem, adjustable memory stop, dual pressure and temperature ports, threaded or soldered connections, brass body, 600 psig at 205 deg F, $\pm$3 percent accuracy.

I. Relief Valves
1. ASME tested and certified.
2. Shall have capacity to handle 100% of service.
3. Shall be set at 10% above the working pressure of equipment or service to which it is connected, or as noted.

4. Shall be iron body with stainless steel trim, renewable discs and seat rings, slow-opening-type.
5. Discharge shall be piped to nearest floor drain and arranged for safe discharge.
6. Manufacturers: Consolidated, Farris, Leslie, Lonergan, Manning-Maxwell-Moore.

J. Temperature Regulators
1. ASME-coded.
2. Shall be pilot operated, of packless construction, for dead-end service.
3. Main valve shall be cast iron body, single-seated, with SECO metal seat, normally closed and guaranteed to shut tight.
4. Shall have an adjustable bi-metal thermostat, with a bronze or stainless steel bulb suitable for the application. Shall be complete with gages.
5. Shall be sized to meet the capacity and service indicated.
6. Shall be installed with strainer, shut-off valves.
7. Manufacturers: Spence Engineering Co., Fisher, A W Cash, McLear.

K. Temperature and Pressure Relief Valves
1. ASME-coded
2. All-bronze construction with seat-to-disc alignment that will not stick or freeze.
3. Shall start to open at 230 deg F and shall be fully open at 240 deg F.
4. Shall have snap action thermostat and sensing bulb sized to water heater Manufacturer's recommendations
5. Manufacturers: Watts, McDonnel, Wilkins, Conbraco.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General
1. Comply with Division 22 Section "Common Work Results for Plumbing", as well as the requirements of Division 22 Sections "Hangers and Supports for Plumbing Piping, and "Plumbing Insulation".
2. Piping shall be installed in a manner which permits easy removal of valves and disconnection of equipment. Unions or flanged joints shall be installed for this purpose.
3. Piping shall be installed, supported, guided, and anchored to properly provide for movement due to expansion and contraction without undue strains on the joints and in such a manner that it will not sag, buckle or sway.
4. Piping shall not be supported from other pipes, conduits, ducts or similar installations.
5. No piping shall be supported by the equipment to which it is connected. Install base elbows, hangers or other approved independent method of support for the pipe.
6. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the run-outs of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
7. No field-fabricated welding fittings shall be permitted. All welding tees, elbows, reducers, and caps shall be commercially manufactured products.
8. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping.
9. All open ends of pipes, including equipment connections, shall be properly sealed at all times during installation to keep dirt and all foreign material out of the piping. Plugs used shall be commercially manufactured products.
10. Pipe size reductions shall be made with factory-fabricated eccentric reducers or reducing fittings and shall be installed in a manner which does not cause pocketing or inhibit the flow of the material.

11. Install shut-off service valves with unions on all connections to equipment and on each side of control valves as required for ease of proper servicing and maintenance; see Division 22 Section "General Duty Valves for Plumbing Piping".
12. Unless otherwise indicated, the discharge from pressure-and temperature-relief valves and equipment drains shall be piped to the nearest floor drain, hub drain, or mop sink, installed with an approved air gap as required, and arranged for safe discharge.
13. No pipe shall penetrate any structural member without the written approval of the A/E. Where such penetration is allowed, the structural member shall be reinforced subject to the approval of the A/E.
14. Flanges and Gaskets
    a. Where forged steel flanges are to be bolted to cast iron flanges, a smooth or flat-face forged steel flange with a full-face gasket shall be used.
    b. All gaskets, other than teflon envelope or full-face, shall be of the flat ring type, with the outside diameter of the gasket extending to the edge of the bolts.
    c. Gaskets for all joints shall have an inside diameter equal to the outside diameter of the pipes on which they are to be used, to ensure that no portion of the gasket will project into the ports of valves, pipe, or fittings.
    d. The dimensions of all gaskets shall conform to ANSI Standard B-16.21 for non-metallic gaskets.
15. Dielectric Separation
    a. Provide dielectric separation at all copper piping and valves connected to ferrous piping.
    b. Brass or bronze valves installed in ferrous piping shall not require dielectric separation.
    c. Connections between copper piping and ferrous flanged piping and equipment connections shall be with a bronze companion flange with dielectric separation for flanges and bolts.
    d. Connections between copper piping and screwed ferrous piping shall be Clearflow Dielectric Waterway fittings.
16. Movement
    a. Mains: Provide adequate offsets, bends, loops, flexible joints and guides as required to prevent over-stressing of piping and/or the structure.
    b. Branches: Provide for expansion and contraction by means of offsets, swings, joints or loops to eliminate stress on connected piping, valves or equipment. Provide for proper drainage as required.
    c. Maintain a free floating, properly braced and supported piping system.
17. Provide all rough-in and final connections to equipment and services indicated in the Contract Documents for equipment and services to be functional.

B. Cross Connections and Interconnections: No plumbing fixtures, devices, equipment or pipe connections shall be installed that will provide a cross-connection or interconnection between a potable water supply and any source of nonpotable water such as a drainage system, a soil or waste pipe, or a boiler or cooling tower where the water may be chemically treated.

C. Painting of Piping: Refer to Division 09 Section "Interior Painting".

3.2 SLEEVES

A. General
1. All sleeves shall be accurately located as required under this Division, and shall be properly sealed. Sleeves shall be set true to line, grade and position, shall be plumb or level, and shall be maintained during the work under other Divisions.
2. Sufficient advance notice shall be supplied to the proper trade to enable the installation to progress.

3. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done by the proper trade at the cost of this Division, with no change in the Contract Sum or the Date of Substantial Completion.
4. Sleeves shall not penetrate any structural member, except as shown on Drawings, without written approval from the A/E. Wherever any additional reinforcing of members is required, the cost shall be under this Division.
5. Provide sleeves when underground piping passes under or through footings/grade beams. Sleeves under footings/grade beams shall have lean concrete from sleeve to underside of footing/grade beam.

3.3 BUILDING PIPING SYSTEM: INSTALLATION

A. Domestic Water: Cold, Hot, Tempered, Recirculating
   1. General
      a. All piping shall be installed and pitched to provide proper drainage.
      b. Install drain valves at all low points and as required to provide drainage facilities for the piping. Wherever system is sectionalized, install drain valves between each sectional shut-off valve.
      c. All hot water piping shall be pitched to provide natural gravity recirculation regardless of a recirculation pump.
      d. Install pressure gauge in domestic cold water main at water entrances to building.
   2. Shock Elimination
      a. All piping shall be protected against water shock.
      b. Install a water hammer arrestor of the proper size at the end of the main, at the end of all branch lines, and at the end of lines serving groups of fixtures.
      c. Water hammer arrestors shall be sized and installed as recommended by the Plumbing and Drainage Institute, and shall eliminate water hammer.
      d. All water hammer arrestors shall be installed in locations where they are readily accessible for service. Where required, provide suitable access doors.
   3. Contamination Protection
      a. All new distribution systems shall be protected against contamination due to backflow from non-potable sources.
      b. Provide an approved backflow preventer of the reduced pressure zone type at each connection to a fixture where indicated or required by code.
      c. Pipe to nearest floor drain.
   4. Backflow Prevention
      a. Install a code approved backflow preventer unit in the service main, where indicated on the Drawings, or as required by code.
      b. Include strainer, dual-service shut-off valves, double-check valves, and check cocks.
      c. Properly support, independent of the piping, with union connections.

END OF SECTION 22 11 16

SECTION 22 13 13
FACILITY SANITARY SEWERS (SITE)

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Nonpressure and pressure couplings.
   3. Cleanouts.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

1.4 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of service without Architect's written permission.

PART 2 PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Profile Sewer Piping:
   1. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D 3034, PVC with bell ends.
   3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D 3034, PVC with bell ends.
   3. Gaskets: ASTM F 477, elastomeric seals.

C. PVC Gravity Sewer Piping:
   1. Pipe and Fittings: ASTM F 679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.2 NONPRESSUER-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

C. Unshielded, Flexible Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dallas Specialty & Mfg. Co.
      b. Fernco Inc.
      c. Logan Clay Pipe.
      d. Mission Rubber Company; a division of MCP Industries, Inc.
      e. NDS.
      f. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   2. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cascade Waterworks Mfg.
      b. Dallas Specialty & Mfg. Co.
      c. Mission Rubber Company; a division of MCP Industries, Inc.
   2. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Fernco Inc.
      b. Logan Clay Pipe.
      c. Mission Rubber Company; a division of MCP Industries, Inc.
   2. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

F. Nonpressure-Type, Rigid Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
   2. Description: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.3 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.
   d. Tyler Pipe.
   e. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
3. Top-Loading Classification(s): Heavy Duty .
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.4 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:
   1. Cement: ASTM C 150, Type II.
   2. Fine Aggregate: ASTM C 33, sand.
   3. Coarse Aggregate: ASTM C 33, crushed gravel.
   4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: 1 percent through manhole.
   2. Benches: Concrete, sloped to drain into channel.
      a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 36-inch minimum cover.
4. Install PVC profile sewer piping according to ASTM D 2321 and ASTM F 1668.
5. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
6. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join PVC profile sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
2. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
3. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

a. Shielded flexible or rigid couplings for pipes of same or slightly different OD.
b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.

c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure pipe couplings for force-main joints.

3.4 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.6 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

B. Connect force-main piping to building's sanitary force mains specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to grease interceptors specified in Section 22 13 23 "Sanitary Waste Interceptors."

3.7 IDENTIFICATION

A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

END OF SECTION

SECTION 22 13 16

BUILDING SANITARY AND STORM DRAINAGE

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Provide a complete building storm water drainage system to 5 feet outside building exterior wall. Work includes, but is not limited to, the following:
      a. Roof drains.
      b. Area drains.
      c. Pipe materials.
      d. Clean-outs.
   2. Provide a complete soil, waste and vent piping system to 5 feet outside building exterior wall. Work includes, but is not limited to the following:
      a. Equipment coordination when equipment or fixtures are supplied by others.
      b. Pipe materials.
      c. Piping auxiliaries/specialties.
      d. Drains.
      e. Clean-outs.

1.3 EQUIPMENT BY OTHERS

A. Include all necessary roughing-in and final equipment connections by the plumbing trade as specified.

B. Wherever equipment is furnished and set in place under Work of another Section or by Owner, they shall furnish detailed Drawings and exact rough-in dimensions and locations at the Site.
   1. Information shall be furnished sufficiently in advance to allow proper installation of all required services.
   2. This Division shall include all required service rough-ins and final connections to the equipment.

1.4 QUALITY ASSURANCE

A. General
   1. Provide all supervision, labor, tools, materials, equipment, accessories and specialties necessary to completely install, clean and test the building sanitary and storm plumbing systems.
   2. All materials shall be free from defects impairing strength and durability and shall be of the best quality for the purposes indicated. All Work shall have structural properties sufficient to solely sustain or withstand strain and stresses to which it is normally subjected and shall be true to detail.

B. Codes and Standards (Division 22 Section "Common Work Results for Plumbing" Listings and the following.)

1. Plumbing installation shall be in accordance with the state and local plumbing code and all other codes having jurisdiction.
2. American Standard Code for Pressure Piping ANSI B31.1.
3. National Association of Corrosion Engineers.
4. American National Standards Institute (ANSI).
5. American Society of Mechanical Engineers (ASME).
6. American Society for Testing and Materials (ASTM).
7. American Water Works Association.
8. Manufacturer's Standardization Society of the Valve and Fitting Industry.
9. Plumbing and Drainage Institute.
10. State or local Plumbing Code, as applicable.
11. State or local Building Code, as applicable.

C. Material Standards
1. ASTM A74-04: Specifications for Cast Iron Soil Pipe and Fittings.
2. ASTM A53-04: Specifications for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses.
3. ASTM B306-02: Specifications for DWV Copper Pipe.
4. ASTM C564-03: Specifications for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
5. Cast Iron Soil Pipe Institute CISPI No. 301-90 and ASTM A888-04: Specification Data for Hubless Cast Iron Pipe Systems with No-Hub Pipe and Fittings.
6. Cast Iron Soil Pipe Institute CISPI No. 310-90: Specification for coupling for use in connection with no-hub cast iron soil pipe and fittings for sanitary and storm drain, waste, and vent piping applications.
7. ASTM C1053-00: Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (OWV) Application.
8. ANSI A112.21.1-91: Floor Drains.
9. ANSI A112.36.2M-1991 (R2002): Metallic Clean-Outs.
10. ANSI A112.1.2-04: Air Gaps in Plumbing Systems.
11. ANSI A112.21.2M-1983: Roof Drains.

1.5 SUBMITTALS

A. Shop Drawings
1. Piping Systems: Submit piping layout drawings for sanitary waste and vent, storm piping, and acid waste systems prior to installation.

B. Product Data: Catalog cuts.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Test reports.
2. Final approvals by authorities having jurisdiction.

1.6 HANDLING, DELIVERY, AND STORAGE

A. General
1. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.
2. No extra cost shall be charged the Owner for handling, delivery, or storage.
3. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. General
1. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
2. No salvaged or used pipe shall be used without the written approval of the A/E or Owner. Wherever such approval is given, recut the ends of the pipe, square, cut new threads on screwed pipe, and thoroughly clean the pipe of all rust, dirt, scale and foreign matter before installation.
3. All cast iron pipe and fittings shall be marked with the trademark of the Cast Iron Soil Pipe Institute and listed by NSF International.

B. Buried Soil, Waste, and Vent Piping
1. ASTM A74 service weight cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed joints.
2. Options
   a. ASTM A888 and CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.

C. Above-Ground Soil, Waste and Vent
1. ASTM A888 and CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.
2. Options
   a. ASTM A74 service weight cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed joints.
   b. ASTM A53 Schedule 40 galvanized steel pipe with cast iron screwed drainage fittings.
   c. ASME A112.3.1 type 316L stainless steel drainage pipe and fittings, spigot, and socket joints with EDPM gaskets.

D. Indirect Waste and Drains Above Ground
1. ASTM B306 DWV copper tubing with DWV copper fittings.
2. Options
   a. ASTM D2665 PVC-DWV plastic pipe, drainage fittings with solvent weld joints.
   b. Same materials as soil, waste, and vent.

E. Interior Buried Storm Piping
1. ASTM A74 cast iron service weight soil pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed.
2. Options
   a. CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.
   b. ASTM D1785 solid schedule 40 plastic pipe with ASTM D2665 drainage fittings and solvent welded joints.

F. Exterior Buried Storm Piping
1. ASTM A74 cast iron service weight soil pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasket or oakum-lead joints.

2. Options: ASTM D3034, Type PSM, polyvinyl chloride (PVC), SDR 35 for solvent cement or elastomeric joints. Fittings to conform to ASTM D2556.
   a. Joints with elastomeric seals (integral bell) shall conform to ASTM D3212. Gaskets shall conform to ASTM F477.
   b. Joints with solvent cement shall conform to requirements of ASTM D2885 and ASTM D2564.

G. Above Ground Storm Piping
1. CISPI 301 hubless cast iron pipe, as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with heavy duty 304 corrugated stainless steel couplings.
2. Options
   a. ASTM A74 service weight cast iron pipe, bitumastic-coated, bell and spigot joints, drainage fittings with ASTM C564 gasketed.
   b. ASTM A53 Schedule 40 galvanized steel pipe with cast iron screwed drainage fittings.
   c. ASTM A112.3.1 type 316L stainless steel drainage pipe and fittings, spigot and socket joints with EDPM gaskets.

2.2 PIPING AUXILIARIES/SPECIALTIES

A. General: All auxiliaries and specialties shall be guaranteed by the manufacturer for the pressure, temperature and materials being handled, and shall be suitable for the piping to which they are attached.

B. Air Gap Fitting
1. J.R. Smith Fig 3951, rough bronze or plain end with set screw, threaded inlet and threaded outlet, sizes as indicated.
2. Manufacturers: Mifab, Watts, Wade, or Zurn.

C. Vent Flashings
1. Furnish 6 lb. lead flashing for General Contractor installation.
2. Flashing shall extend 12 inches in all directions, sealed between roofing plies, extended up to end of vent and clamped with vandalproof vent cap.
3. Vents Thru Roof (VTR): Refer to Architectural Drawings for vent thru roof detail in EPDM roof.

D. Storm and Sanitary Piping Hubless Cast Iron Couplings
1. Shield constructed of type 304 stainless steel meeting ASTM 240. Neoprene gaskets shall conform to ASTM C564.
2. Couplings shall have a minimum of 4 bands and be capable of tightening to 80 lbs. torque.
3. The use of sealant or adhesives on couplings is not permitted unless approved by the manufacturer.
4. Couplings shall be heavy duty in accordance with ASTM C1540.

F. Cast Iron No-hub Restraints
1. Cast iron no-hub horizontal pipe and fittings, larger than 4", shall be suitably braced to prevent horizontal movement. Install at every branch opening or change in direction by the use of braces, blocks and rods to prevent movement or joint separation. This bracing may be field fabricated or a manufactured system.
2. Holdrite 117 series or equal.

2.3 DRAINS

A. General
1. All drains installed in waterproofed slabs shall be provided with a flashing ring.
2. Install a 30-inch x 30-inch x 6 lb. lead flashing properly fastened to the flashing ring.
3. Cast Iron roof, area, and floor drain manufacturers: J.R. Smith, Josam, Kusel, Mifab, Wade, Watts and Zurn.
4. Corrosion resistant floor drain manufacture: Zurn, Enfield, Kusel, Orion, R&G Sloan, and Duriron.

B. Roof Drains
1. RD1: Zurn Z100, large, general purpose roof drain with cast iron body, cast iron dome, bottom outlet, adjustable extension sleeve, reversed collar, flashing clamp with gravel stop, sump receiver, and underdeck clamp. Provide expansion joint on all bottom outlet roof drains. Size of piping on plan indicates outlet size of roof drains.
2. OFD1: Zurn Z100-89, flooding dam-type with 2-inch cast iron water collar, cast iron body, cast iron dome, bottom outlet, extension, flashing clamp with gravel stop, sump receiver, underdeck clamp. Provide expansion joint on all bottom outlet roof drains. Size of piping on plan indicates outlet size of roof drain.
3. DSN1: Zurn Z199-SS, downspout nozzle, polished bronze body, NPT threads, wall flange with mounting holes. Size of piping on plans indicates outlet size. Provide with removable stainless steel screen.

C. Floor Drains
1. FD1: Zurn Z415S-DP, adjustable cast iron body, round nickel bronze strainer. Caulk outlet. Contractor shall buff strainer to be suitable for barefoot traffic in shower areas. FD1 shall have a square top.
2. FD2: Zurn Z507-NH, cast iron body, medium duty drain, bronze top. Size as indicated on Drawings.

2.4 CLEANOUTS

A. General
1. Capable of adjustment to match finish surface.
   a. Be round.
2. All cover plates/plugs shall be permanently labeled to match the drain service.
3. For cast iron fittings
4. Cast Iron clean-out manufacturers: Josam, J.R. Smith, Mifab, Wade, Zurn, Watts
5. Corrosion-Resistant Clean-Out Manufacturer: Duriron.

B. Clean-Out Types
1. Floor Clean-Outs
   a. Finished Floor and Tile Floor: J. R. Smith Fig. 4020, Duco cast iron body and frame with round adjustable scoriated nickel bronze top. Top Labeled Co. Provide nickel bronze carpet clamping frame with vandalproof screw in carpeted areas.
   b. Unfinished Floor and Equipment Area Floor: J. R. Smith Fig. 4240, Duco cast iron body and frame with round adjustable scoriated cast iron top. Top Labeled Co.
   c. Corrosion resistant: Provide Duriron clean-out plug with floor access housing.
      1) Finished Floor and Tile Floor: Zurn ZN-1404-VP floor access housing. ABS body with round nickel bronze top. Top Labeled Co.
      2) Unfinished Floor: Zurn Z-1404-VP floor access housing. ABS body with round Dura-coated cast iron top. Top Labeled Co.
2. Wall Cleanouts
   a. J. R. Smith Fig. 4422, Duco cast iron caulk ferrule with vast bronze taper thread plug and prime-coated steel shallow cover. Vandalproof screws.
   b. Corrosion resistant: Provide Duriron plug. Provide with J.R. Smith Fig. 4720 wall access cover with frame, chrome-plated bronze. Vandalproof screws.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General
1. Comply with Division 22 Section "Common Work Results for Plumbing".
2. Piping shall be installed in a manner to permit easy removal of valves and disconnection of equipment. Unions or flanged joints shall be installed for this purpose.
3. Piping shall be installed, supported, guided, and anchored to properly provide for movement due to expansion and contraction without undue strains on the joints and in such a manner that it will not sag, buckle or sway.
4. Piping shall not be supported from other pipes, conduits, ducts or similar installations.
5. No piping shall be supported by the equipment to which it is connected. Install base elbows, hangers or other approved independent method of support for the pipe.
6. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the run-outs of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
7. No field-fabricated welding fittings shall be permitted. All welding tees, elbows, reducers, and caps shall be commercially manufactured products.
8. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping.
9. All open ends of pipes, including equipment connections, shall be properly sealed at all times during installation to keep dirt and all foreign material out of the piping. Plugs used shall be commercially manufactured products.
10. Pipe size reductions shall be made with factory-fabricated eccentric reducers or reducing fittings and shall be installed not to cause pocketing or inhibit the flow of the material.
11. No pipe shall penetrate any structural member without the written approval of the A/E. Where such penetration is allowed, the structural member shall be reinforced subject to the approval of the A/E.
12. Provide all rough-in and final connections to equipment and services indicated in the Contract Documents for equipment and services to be functional.

B. Cross Connections and Interconnections: No plumbing fixtures, devices, equipment or pipe connections shall be installed that will provide a cross-connection or interconnection between a potable water supply and any source of nonpotable water such as a drainage system, a soil or waste pipe, or a boiler or cooling tower where the water may be chemically treated.

3.2 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendices.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendices.

3.3 SLEEVES: INSTALLATION

A. General
1. All sleeves shall be accurately located as required under this Division. Sleeves shall be set true to line, grade and position, shall be plumb or level, and shall be maintained during the work under other Divisions.
2. Sufficient advance notice shall be supplied to the proper trade to enable the installation to progress.
3. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done by the proper trade at the cost of this Division, with no change in the Contract Sum or the Date of Substantial Completion.
4. Sleeves shall not penetrate any structural member, except as shown on Drawings, without written approval of the A/E. Wherever any additional reinforcing of members is required, the cost shall be under this Division.
5. Provide sleeves when underground piping passes under or through footings/grade beams. Sleeves under footings/grade beams shall have lean concrete from sleeve to underside of footing/grade beams.

3.4 FLASHINGS: INSTALLATION

A. General
1. All penetrations of roofs and similar areas required for installation of vents, roof drains, and piping under this Division shall be properly flashed and made watertight.
2. Coordinate with all necessary General Trades Work sufficiently in advance and install in conjunction with roofing installation.

B. Flashing of Vent and Soil Pipe Extensions: All vent and soil pipe extensions through roof shall be minimum 3-inch size and flashed with 6 lb. sheet lead or 16 oz copper, 24-inch square, with sleeve soldered on, extending to top of pipe and turned down 2-inch inside.

C. Flashing of Roof Drains: All roof drains shall be flashed with 6 lb. sheet lead extending 12 inches from outer edge of drain opening.

D. Flashing of Curbs
1. Curbs shall be flashed under the General Trades Divisions of this Specification.
2. Provide counterflashing as required for weathertight construction.

3.5 BUILDING DRAINAGE SYSTEM: INSTALLATION

A. General
1. All storm and sanitary lines shall be of the sizes noted and routed as indicated.
2. Unless otherwise indicated or required by codes, all building drains shall be installed with a minimum uniform grade of one percent (1%).
3. No underground drains shall be installed in water. Trenches shall be dry and acceptable before laying of pipe.
4. All overhead lines shall be installed as close to the building structure as possible.
5. All overhead cast iron drains shall be supported at each joint, each change of directions, each cast iron trap, and all necessary intermediate points to maintain a uniform pitch without sagging or pocketing of the line.

B. Floor Drains
1. Install floor drains with lead flashing in waterproof floors per manufacturer's recommendations.
2. Install floor drains 1/2-inch lower than finished floor elevations to ensure positive drainage. Coordinate installation closely with General Contractor.

C. Cleanouts
1. Install at each of the following points, but not limited to:
   a. Base of each soil and waste stack
   b. Base of interior storm downspouts
   c. Change of direction of 45 deg or greater in the building drains
   d. Inside where the drains leave the building
   e. Where a battery of wall hung water closets are installed, provide cleanout at end of sanitary line in wall.
   f. Where indicated
   g. Install on continuous runs of the drains at 100' intervals on the storm and sanitary.
   h. As directed by local code
2. Shall be connected to the main with long sweep or sanitary wye fittings, unless otherwise noted.
3. Shall be installed to match the finished surface line.
4. Removable plugs shall be lubricated with a mixture of grease and graphite.

D. Traps
1. Install on all floor drains, all waste and soil discharge connections, and where indicated. Locate for ease of service. Any other traps required by official bodies having jurisdiction shall be installed at no additional cost to the Owner.
2. Where traps on plumbing fixtures are installed below grade or otherwise concealed, a clean-out shall be installed in the adjacent finished surface as indicated.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

END OF SECTION 22 13 13

SECTION 22 33 00
DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Electric water heater.
   2. Recirculation pumps.
   3. Thermostatic mixing valves.
   4. Expansion tanks.
   5. Accessories.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
   1. Product data, including rated capacities of selected models, weights (shipping, installed and operating), furnished specialties, accessories, dimensions, required clearances, methods of assembly of components, piping and wiring connections.
   2. Wiring diagrams from manufacturers, detailing electrical requirements for electric power supply wiring to water heaters. Include ladder-type diagrams for interlock and control wiring required for final installations of water heaters and controls. Differentiate between portions of wiring that are factory-installed and portions that are to be field-installed.

1.4 QUALITY ASSURANCE

A. UL Standards: Provide water heater complying with the following:
   1. UL 1453, Electric Booster and Commercial Storage Tank Water Heaters.

B. Electrical Component Standard: Provide components complying with NFPA 70, National Electric Code.

C. Listing and Labeling: Provide water heaters that are listed and labeled.
   1. The terms "listed" and "labeled" shall be as defined in the National Electric Code, Article 100.
   2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

D. ASHRAE Standards: Provide water heaters with performance efficiencies not less than prescribed in ASHRAE 90A, Energy Conservation in New Building Design.

1.5 WARRANTY

A. Special Project Warranty
   1. Submit a written warranty, executed by manufacturer, agreeing to repair or replace water heater units that fail in materials or workmanship within the specified warranty period.

Failures include, but shall not be limited to, tanks. This warranty shall be in addition to, and a limitation of, rights the Owner may have against the Contractor under the Contract Documents.

2. Warranty period is 3 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRIC-TANK-TYPE WATER HEATER

A. Insulation: Fiberglass or polyurethane foam, surrounding tank.

B. Jacket: Steel, with baked-on enamel finish.

C. Tank: Glass-lined steel with anode rods and drain valve. Rated for 150 psi working pressure.

D. Heating Elements: Screw-in or flange bolt-in immersion-type, in multiples of 3 elements.

E. Controls: Adjustable immersion thermostat.

F. Safety Controls: Automatic, high-temperature-limit cut-off and low water cut-off.

G. Temperature and Pressure Relief Valve: ASME-rated and labeled.

H. The porcelainized glass-lined tank shall be protected:
1. Against failure due to overheating caused by build-up of scale, film or other sediments by a cold water inlet tube, which is an integral part of the heater, that churns and agitates particles of sand, silt or scale present in water, so they are carried out of the water heater on successive hot water draws.
2. Against electrolytic corrosion by magnesium anode rods.

I. Water heater tank(s) shall be covered by a 3-year limited warranty against failure due to metal fatigue or overheating caused by buildup of sand, sediment or sludge.

J. Heater to be set to maintain 140 degrees in the storage tank.

K. Manufacturers: A.O. Smith, State, Ruud, Lochinvar

2.2 RECIRCULATING PUMPS

A. In-line all lead-free bronze pump with gauge ports at nozzles and with vent and drain ports. Ceramic or carbon steel shaft supported by permanently lubricated carbon or steel bearings. Pump suitable for continuous operation at 230 deg F at 150 psi working pressure. Built-in overload protection. Motor shall be non-overloading at any point on the pump curve. Capacity and electrical characteristics as noted on the Drawings.

B. Manufacturers: Bell & Gossett, Grundfos, TACO, Armstrong.

2.3 THERMOSTATIC MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Armstrong International, Inc.
b. Lawler Manufacturing Company, Inc.
c. Leonard Valve Company.

d. Powers; a division of Watts Water Technologies, Inc.
e. Symmons Industries, Inc.
f. Bradley Corp.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components. Lead-free design.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, wall mounting bracket, and adjustable temperature-control. Thermometer on outlet.
8. Tempered-Water Setting: As noted on Drawings.
9. Valve Finish: Rough bronze.
10. Refer to Drawings for design characteristics such as flow rate and pressure drop.

2.4 EXPANSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
1. Available Manufacturers
a. AMTROL Inc.
b. Armstrong Pumps, Inc.
c. Elbi of America, Inc.
d. Taco, Inc.
e. Watts Regulator Co.
f. Wessels Co.
2. Construction
a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread. Include tap for pressure gauge.
b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.
d. ASME rated.
3. Capacity and Characteristics
a. Working-Pressure Rating: 150 psig.
b. Capacity Acceptable: Refer to Schedule on Drawings.
c. Air Precharge Pressure: Set air pressure equal to incoming water pressure downstream of water service backflow preventer.

2.5 WATER HEATER ACCESSORIES

A. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) WITH ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

D. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

E. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

F. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.

G. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Construct concrete equipment base.

B. Install reinforcing bars, tied to frame and place anchor bolts and sleeves using manufacturer's installation template.

C. Place concrete and allow to cure before installation of equipment.

3.2 WATER HEATER INSTALLATION

A. General: Install water heaters on 4-inch concrete bases. Set and connect units in accordance with manufacturer's written installations instructions. Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances. Orient so controls and devices needing servicing are accessible.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections of Division 22. The drawings indicate general arrangement of piping, fittings and specialties. The following are specific connection requirements:
   1. Install piping adjacent to equipment arranged to allow servicing and maintenance.
   2. Connect hot and cold water piping to units with shut-off valves and unions. Extend relief valve discharge full-size to closest floor drain.
      a. Where water heater piping connections are dissimilar metals, make connections with dielectric fittings or dielectric unions specified in Division 22 Section “Common Work Results for Plumbing”.
      b. Install expansion tanks at cold water inlet piping as shown on drawings.
   3. Install drain as indirect waste spill into open drain or over floor drain.
      a. Install drain valves at low point in water piping, for water heaters not having tank drain.

B. Electric Connections
   1. Power wiring and disconnect switches area specified in Division 26.
   2. Grounding: Connect unit components to ground in accordance with the National Electric Code.

3.4 FIELD QUALITY CONTROL

A. General
   1. Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate and train Owner's maintenance personnel as specified below.

2. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing and preventative maintenance.
1. Review data in Operating and Maintenance Manuals. Refer to Division 01 Section "Contract Close-Out".
2. Schedule training with at least 7 days' advance notice.

3.5 COMMISSIONING

A. Perform the following before start-up final checks:
1. Fill water heater with water.
2. Piping system test complete.
3. Check for pipe connection leaks.
4. Test operation of safety controls and devices.

B. Perform the following start-up procedures:
1. Energize circuits.
2. Adjust operating controls.
3. Adjust hot water outlet temperature setting.

END OF SECTION 22 33 00

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Inclusion of all plumbing fixtures, complete and ready for use.
      a. All fixtures, except as otherwise specified, shall be constructed of vitreous china with all visible exposed surfaces glazed.
   2. Providing all stops, traps, escutcheons, connections, etc., as are necessary to complete the installation of each fixture, whether such items are listed or not.
   3. Plumbing Trim
      a. All finished exposed faucets, traps, connecting piping, stops, flush valves and other fixture trim shall be chromium-plated brass unless otherwise specified and shall be supported rigidly to fixtures and to walls with matching brackets at not more than 2'-0" center. All fastenings shall be chromium-plated brass or may be 302 stainless steel if of matching color and finish.
      b. Faucets shall be furnished as required. All faucets shall be lead-free.
      c. Vacuum breakers shall be provided as a part of the fixture trim wherever there is a possibility of back-siphoning.
   4. Fixture Stops
      a. Shut-offs for urinal and water closet flush valves shall be an integral part of the fixture or fitting; shut-offs for all other fixtures shall be loose-key, lock-shield-type.
      b. All fixture stops shall be angle- or straight-type adapted for each particular location and shall be located immediately adjacent to the fixture. Use threaded adaptors when used in conjunction with copper tube work. All stop valves shall be lead-free

1.3 QUALITY ASSURANCE

A. Meet the requirements of the following:
   1. State Plumbing Code.
   2. State Department of Housing, Buildings and Construction.
   3. 42 USC 300G: The Reduction of Lead In Drinking Water Act.

B. Material Standards
   1. ANSI/ASME A112.19.2-2003: Vitreous China Plumbing Fixtures.
   2. ANSI/ASME A112.19.3-2000 (R2004): Stainless Steel Plumbing Fixtures (Designed for Residential Use).
   3. ANSI/ASME A112.19.4M-94: Porcelain Enameled Formed Steel Plumbing Fixtures.
   4. ANSI/ASME A112.19.5-1999: Trim for Water Closet Bowls, Tanks, and Urinals.
   5. ANSI/ASSE 1016-90: Performance Requirements for Thermostatic, Pressure Balancing and Combination Control Valves for Bathing Facilities.
   6. ANSI/ASSE 1025-78: Performance Requirements for Diverters for Plumbing Faucets with Hose Spray, Anti-Siphon-Type, Residential Applications.

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Catalog cuts, including all fixture trim.

C. Samples: Not required for review.

D. Project Information: Not required for review.

E. Contract Close-Out Information
   1. Operating and maintenance data.
   2. Guarantees.

PART 2 - PRODUCTS

2.1 MATERIALS - GENERAL

A. Acceptable Manufacturers
   1. Plumbing Faucets (Commercial Grade): American Standard, Chicago Faucet, Delta, Moen, Powers, Symmons, Speakman, T&S Brass Co., and Hydrotek.
   2. Vitreous China Plumbing Fixtures: American Standard, Kohler, Eljer, Zurn.
   3. Mop Sinks
      a. Terrazzo: Crane, Creative Industries, Fiat, Florestone, Stern and Williams.
   4. Closet Seats: Church, Sperzel, Olsonite, Beneke, Centoco.
   5. Stainless Steel Sinks: Elkay, Just, Metcraft, Southern Kitchens.
   6. Electric Water Coolers: Elkay, Haws, Oasis, Halsey-Taylor.
   7. Carriers: Josam, Mifab, Smith, Wade, Watts, Zurn.
   8. Supply Stop Valves: Brasscraft, McGuire, Nibco, Watts.

B. Plumbing Fixtures – General: Constructed or equipped with anti-siphon devices to prevent siphoning waste material into potable water supply system.

C. Escutcheons and Plates: Conceal all holes where pipes pass through walls, floors or ceilings; use plates or escutcheons.

D. Piping Exposed in Finished Areas (including fittings and trim): Chromium-plated or nickel-plated brass with polished bright surface.

E. Trim for Lavatories and Sinks: Provide with renewable cartridges.

F. Vitreous Caps: Provide for water closet bolts.

G. Sealant: Silicone-type. See Division 7 Section “Joint Sealants”.

2.2 CHAIR CARRIERS

A. Carriers for Lavatories: Josam 17100, 17100-76.

B. Carriers for Electric Water Coolers: Josam 17900 or 17905.

C. Carriers for Service Sinks: Josam 17720.

D. Carriers for Water Closets: Josam 12000 Series.

2.3 INSULATION AT HANDICAPPED (ADA-COMPLIANT) LAVATORIES

A. Insulation
   1. Handicapped lavatories exposed waste, hot and cold water supply lines shall be insulated with a molded, flexible vinyl insulation system with all fasteners. Provide insulation for 1-1/4-inch waste offset drain, tailpiece, P-trap and waste arm and 3/8-inch supply tubing and 3/8-inch keyed stop valve. Color shall be white.
   2. Manufacturers/Products
      a. IPS Corp Truebro Lav-Guard 2.
      b. Plumberex Pro-Extreme.
      c. McGuire ProWrap.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sink manufacturer shall provide proper template to architectural woodwork supplier for cutting of countertop.

B. Plumber shall place sink in countertop and complete faucet and piping.

C. Install all fixtures in accordance with Manufacturer's recommendations.

D. All fixture support carriers shall be of the type necessary to permit adjustment to fit variations in construction. All grounds or special supports necessary for setting fixtures shall be provided before plastering or other finished construction work is begun. All fixtures shall be hung at standard height unless otherwise indicated by the A/E.

E. Minimum fixture connection sizes are shown on the Drawings.

F. Provide chrome-plated brass escutcheons on all waste and supply piping penetrating the walls and floors for fixtures, including piping within cabinets.

G. Provide fixture carriers and required drainage fittings on all wall hung fixtures. Anchor carriers securely to floor.

H. Where plumbing fixtures abut to walls, floors, and countertops, seal all joints with sealant.

I. Seal floor sinks to wall and floor with building sealant. Color shall match fixture.

J. Adjust self-sustaining closet seats for proper operation and to sustain in any position.

K. Adjust electric water coolers flow for correct operation and temperature.

L. Insulate the hot and cold water and waste piping under handicapped lavatories.

M. After all fixtures have been set and are ready for use, and before the Contractor leaves the job, he/she shall thoroughly clean all fixtures furnished and set by him, removing all stickers, rust stains and any other matter or discoloration of fixtures, leaving every part in new condition. He/she shall, further, adjust all flush valves and other fixture water tempering or balancing at supplies to give proper water flow of fixtures.

END OF SECTION 22 40 00

SECTION 230500 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work under this Section includes, but is not limited to, providing all labor, material, equipment, and services necessary for completion of all mechanical systems in a serviceable fully operational manner.

B. All items of Work and systems shall be furnished and installed ready for satisfactory operation and all required apparatus and service shall be provided even though not specifically mentioned herein.

C. The Contract Specifications and Contract Drawing Equipment Schedules list the equipment manufacturers selected for the basis of the Specifications and for the various individual equipment layouts on the Contract Drawings. Substitutions shall be made in accordance with General Conditions and as otherwise provided in the Contract Documents.

D. The Drawings showing the layout, arrangements, sizes and principal connections to the equipment and apparatus are based on one particular type of equipment of an acceptable manufacturer. If equipment other than the particular type shown on the layout Drawings is used, it is the Contractor's sole responsibility to make all necessary modifications to related piping, ductwork, electrical and utility connections, apparatus and miscellaneous items to complete the Mechanical Work, ready for satisfactory operation required under these Specifications. The cost of making all the modifications shall be borne by this Contractor without extra cost to the Owner, Architect or Engineer. In using such equipment, it is imperative that the equipment must fit the space and the access allotted, with the final layout to be approved by the Architect/Engineer (A/E). Follow the Drawings as closely as actual building construction permits.

E. The Drawings show the principal engineering design elements of the mechanical installation. They are not intended as detailed construction installation drawings for the Mechanical Work but as a complement to the Specifications to clarify the principal features of the mechanical systems. It is the intent of this Section that all equipment and devices, furnished and installed under this and other Sections, be properly connected and interconnected with other equipment so as to render the installation complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Contract Specifications or shown on the Contract Drawings.

F. Check the layout of the Work of this Division, as indicated on the Drawings. Determine exact locations by the dimensions of the equipment approved. Obtain written approval from the Engineer for any revised layout before equipment or material involved is installed. Consult the Architectural and Structural Drawings for all dimensions, locations of partitions, locations and sizes of structural supports, foundations, swings of door, and other detail information required for a correct installation of this Work.

G. Examine all other Divisions of the Contract Documents for Work related to the Work of this Division. Cooperate to provide continuity of Work, to eliminate duplications, and to provide

Mechanical Work in support of such related Work. Furnish to other trades and on schedule all information required for the execution of Mechanical Work.

H. Any additional Work such as cutting, drilling, patching, excavating, moving of another trade's work because of delay in Mechanical Work or lack of information is a part of this Division and shall be performed without increase in Contract Price.

I. Install and connect devices and equipment in accordance with the best engineering practice and the manufacturer's instructions and recommendations. Provide all incidental ductwork, piping, valves, connections, and all similar material recommended by the manufacturer, or required for proper operation and maintenance, complete without additional costs.

J. Provide all necessary rigging, scaffolding, tools, tackle, labor and other materials or equipment which may be necessary for the completion of the Work.

K. Furnish and install motor on proper frame designed by the equipment manufacturer.

L. All control wiring associated with the mechanical systems shall be provided under Division 23. All wiring shall comply with Division 26 Standards.

1.2 SPECIFIED ELSEWHERE

A. The following will be provided under other sections of the Specifications:
1. Openings: Walls, floor, ceiling and roof opening specifically shown and identified on the Architectural/Structural Drawings will be provided under other Divisions. Openings not so identified that are required for Mechanical Work, or changes to such openings are part of the Work of this Mechanical Division.
2. Curbs, Drains and Sleeves: Drains and roof sleeves provided under this Division shall be incorporated into the finished roofing and made watertight under another Division.
3. Equipment Bases: Concrete equipment bases, mounting slabs, and housekeeping pads specifically shown and identified on the Mechanical Drawings shall be provided under this Division. Supervise their installation. Those bases, not so identified and indicated on the Architectural and Structural Drawings, shall be provided under other Divisions. Cooperate and furnish dimensions, sleeves, inserts, hold-down bolts, and templates for their installation.
4. Painting: Painting of all exposed-to-view pipes, ducts, hangers, supports, and equipment, shall be performed under another Division. Under this Division, all manufactured equipment shall be furnished with factory-finished baked enamel, unless otherwise specified.
5. All power wiring associated with equipment provided under this Division shall be furnished, installed, and wired in accordance with Division 26. Under Division 23, provide installation instructions, locating dimensions, and wiring diagrams for the other trades. Supervise the installation and start-up and test the equipment.

1.3 RELATED WORK

A. The Drawings, General Provisions of the Contract, General Conditions, General Requirements, Supplemental General Conditions and Division 01 through 26 all apply to the work in this Section.

1.4 DEFINITIONS

A. Provide: Furnish, install and connect up complete and ready for operation of particular work referred to, unless specifically otherwise noted.

B. Furnish: To purchase, procure, acquire and deliver complete with related accessories.

C. Install: To erect, mount and connect for use complete with related accessories.

D. Work: Labor, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

E. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.

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

G. Accessible: Capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, ductwork or going through doors or false ceilings.

H. Words: Words used in the singular number shall include the plural sense and vice versa.

I. Wiring: Wire or cable installed in conduit, with all required boxes, fittings, supports, connections, etc.

J. Power Wiring: That wiring between the source of power and the current consuming device such as motors, equipment, heaters, etc. It includes the installation of such control devices in the power circuit such as pushbuttons, thermostats, key switches, timers, etc., which control loads for which no magnetic starter or contactor is provided for controls.

K. Control Wiring: That wiring between control devices that does not provide the power circuit, regardless of voltage, when a magnetic starter or contactor is provided for control.

1.5 INTENT

A. Furnish, erect, install, connect, clean, adjust, test and place in service all materials, equipment and systems in accordance with applicable codes, manufacturer's directions and recommendations for all work shown on the drawings and called for in the Specifications.

B. Carefully examine the contract documents, visit the site, and thoroughly become familiar with the local conditions relating to the work. Failure to do so will not relieve the contractor from any obligations of the Contract.

C. Should there be any discrepancies of a question of intent, refer the matter to the Architect/Engineer for a final decision before ordering any equipment/materials or before starting any related work.

D. In case of conflict between project specifications and drawings, drawings govern unless the Architect/Engineer rules otherwise.

E. Apparatus, devices, materials of work not specifically shown on drawings, but mentioned in the project specifications, or vice versa, or any incidental accessories and appurtenances necessary

to make the work complete and ready for operation, even though not specified or shown on the drawings, shall be furnished and installed without additional expense to the Owner.

F. It is the contractor's responsibility prior to bids to review all project documents.

G. Project documents include architectural, structural, mechanical, control, plumbing, fire protection and electrical disciplines.

1.6 CODES AND STANDARDS

A. Applicable Publications: Reference made herein to standards, Specifications, or codes, refer to the latest edition including all addenda, errata, or other revisions thereto, existing on the date of execution of the Contract.

B. Local Codes and Ordinances: Install all Work in conformance with all applicable local Codes and state ordinances and statues. Nothing in the Specifications or Drawings shall be construed to permit deviation from the governing codes. In case of conflict with local ordinances and statues, the more stringent shall apply.

C. Abbreviations: Refer to Division 01, Abbreviations and Symbols under Mechanical Sections make use of the following abbreviations in adopting applicable standards and codes as a part of Division 23:

1. ADC - Air Diffusion Council - Test Code
2. AGA - American Gas Association
3. AIA – American Institute of Architects
4. AMCA - Air Moving and Conditioning Association
5. ANSI - American National Standards Institute
6. API - American Petroleum Institute
7. ARI - Air Conditioning and Refrigeration Institute
8. AGA - American Gas Association
9. ASHRAE–American Society of Heating, Refrigeration and Air Conditioning Engineers
10. ASME - American Society of Mechanical Engineers
11. ASTM - American Society for Testing and Materials
12. AWS - American Welding Society
13. AWWA - American Water Works Association
14. EPA - Environmental Protection Agency
15. FM - Factory Mutual System
16. IMC – International Mechanical Code
17. IPC – International Plumbing Code
18. IRI - Industrial Risk Insurers
19. MSS - Manufacturers Standardization Society
20. NACE – National Association of Corrosion Engineers
21. NEC - National Electric Code
22. NEMA - National Electrical Manufacturers Association
23. NFC - National Fire Code
24. NFPA - National Fire Protection Association
25. NPC - National Plumbing Code
26. NSF – National Sanitation Foundation
27. OSHA - Occupational Safety and Health Standards
28. PDI – Plumbing and Drainage Institute
29. SMACNA - Sheet Metal and Air Conditioning Contractor's National Association

30. UL - Underwriters Laboratories, Inc.
31. State and Local Fire Marshall
32. State and Local Inspection Authorities
33. Owner District's Fire Insurance Agency requirements
34. The Division 01 Sections "Regulatory Requirements" and Reference Standards of the Project Specifications

D. Permits and Inspections
1. Obtain and pay for all permits, bonds, licenses, etc. required by the Local, State or other authority having jurisdiction over the work.
2. Arrange and pay for inspections required by the above when they become due as a part of the work of the Sections affected. Conceal no work until approved by these governing authorities. Present the Owner with properly signed certificates of final inspection before the Owner's acceptance of the Work.
3. Obtain and pay for all meters, gauges, instruments, and devices required by the governing authorities except as otherwise noted as part of the Work of the Sections affected.

1.7 QUALITY ASSURANCE

A. All materials furnished shall be new and shall comply with all applicable standards listed below.

B. All materials or work found to be defective or not in strict conformity with the Contract Documents, or defaced or injured through any cause, shall be rejected, and shall be removed by Contractor and satisfactory material and Work substituted without delay.

C. Contractor shall protect his/her Work by keeping all piping, equipment, etc., capped or plugged, drained, or otherwise protected from injury by freezing, water damage, or stoppage from material, concrete, sand, or dirt and shall repair any such injury without additional charge to the User. Injury shall be interpreted to include scratches, discoloring and denting.

D. Contractor will be held responsible for any damage caused by him/her to other Contractors' Work.

E. Submit shop drawings and product data for all equipment as specified or scheduled. Update all drawings to "as-built" status and submit to Architect/Engineer digitally or on flash drive.

1.8 SUBMITTALS

A. Submit under provisions of Division 01 and as specified herein. The most stringent requirements shall apply.

B. General: Within 15 calendar days after date of Contract Agreement, submit to the Engineer a typewritten list of all items of equipment and material proposed for installation on this project. Provide the specification page number, manufacturer's name, model number, size non-standard accessories specified or required, and any other information required to identify each item.
1. Within 30 days after the Contractor has been given notice of approval of manufacturers, submit shop drawings of equipment and material proposed for this installation.
2. If substitutions have been offered in lieu of specified materials and/or equipment they shall be in accordance with AIA Document A201.

C. Shop Drawings: Submit shop drawings for all Work to be done under each of the Mechanical Sections and for all items and assemblies which are to be specifically fabricated for this Contract.

D. The Engineer's review of Manufacturer's Drawings or Schedules shall not relieve the Contractor from responsibility for errors or omissions in Manufacturer's Drawing and deviations from the Contract Drawings or Specifications.

E. Coordination and Fabrication Drawings: Prepare layout drawings of all system assemblies of this Contract including plumbing, heating, sprinkler piping, electrical and technology, mechanical and electrical room layouts with equipment and piping, ductwork installations, and control systems. Include completely dimensioned plans drawn to scale. Show elevations and sections indicating locations of all equipment, piping, ductwork, drains, controls, and other items with reference to columns, walls, slabs, beams, and to components of other systems and work of other trades. Floor plans shall be drawn at not less than 1/4-inch scale with a sign-off block including all disciplines and date. Tracing or reproduction of Construction Documents is not acceptable. Provide a minimum of one reproducible drawing and five prints of each drawing.

F. Survey, Measurements and Grade: The Contractor shall lay out their work and be responsible for all necessary lines, levels, elevations and measurements. The Contractor must verify the figures shown on the Plans before laying out the work and will be held responsible for any error resulting from failure to do so. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work. Should the Contractor discover any discrepancy between actual measurements and those indicated which prevents following good practice or the intent of the contract documents, the Contractor shall promptly notify the Engineer and shall not proceed with this work until the Contractor has received instructions from the Engineer on the disposition of the work.

G. Electronic files containing AutoCAD Floor Plans or Revit models are available through the Engineer. Cad drawing format shall be AutoCAD 2017 unless requested otherwise. Revit models shall be in the version in which they are created. The Contractor shall complete, sign, and submit a "Model Sharing Agreement" form which is available from the Architect/Engineer by request. Fees may apply for these electronic files.

H. Catalog Cuts: Submit manufacturer's data sheets and pictures of all standard manufactured items proposed for installation in this project. Clearly identify each item proposed, together with all required accessories and fittings, with tag numbers and specification page and line numbers. Include graphs, curves, or charts, as applicable, with the specified operating point clearly marked.

I. Installation and Bolt Setting Diagrams: Submit complete installation instructions and bolt setting information for items of equipment furnished under Division 23 such as pumps, fans, compressors, tanks, filters, pressure vessels, etc.

J. Wiring Diagrams: Provide specific wiring diagrams and instructions for all equipment, controls or devices which are furnished under Division 23 and are to be wired and connected by other trades. The diagrams and instructions shall not be of a general or typical nature, but shall be applicable and specific to this Contract.

K. Samples: Where a Contractor proposes a manufacturer, material, or method differing from that specified, the Engineer may require samples illustrative of the manufacturer, material or method. Submit such samples as part of the shop drawing requirements, and shall include samples of insulation, special finishes, etc.

L. Submittals shall be made in accordance with the General Conditions of the Contract and as otherwise required in the Contract Documents. In submitting shop drawings, illustrations and descriptive material for approval of the Engineer, the Contractor must clearly mark each shop drawing, catalog cut, pamphlet or specification sheet as follows, for purposes of identification and record:
1. Date: (as submitted)
2. Project Title:
3. Location of Project:
4. Branch of Work: (HVAC, Plumbing, Fire Protection, etc.)
5. Specification Paragraph & Page:
6. Submitted by: (Contractor Name)
7. Contract No.:

1.9 SUBSTITUTIONS

A. Product substitutions shall be in accordance with the General Conditions, Supplemental General Conditions, Division 01 and as specified.

B. The products, equipment, etc. scheduled on the Drawings or specified are the basis of design. Where more than one manufacturer is listed, the Contractor may use any of the acceptable manufacturers as the basis of their bids unless otherwise specified. However, the Contractor assumes all responsibility for changes to the design, installation, etc. as a result of the change, i.e.: power characteristics, physical size, etc.

C. Any request for substitution to other than the specified acceptable manufacturers must be submitted to the Engineer in writing and shall include an adequate description of proposed change, reason(s) for requesting change and cost adjustment information. Substitutions not submitted in this manner will be rejected automatically. Substitution requests will only be considered for the following reasons:
1. Specified manufacturer(s) is no longer in business.
2. Specified product(s) cannot be delivered within the required project schedule.
3. Alternate product(s) is of equal quality, but better value with savings offered to the Owner.

1.10 PROJECT RECORD DOCUMENTS

A. Maintain Project Record Drawings during construction in accordance with General Conditions and as specified.

B. Provide Project Record Drawings at completion of project. Shop drawings are not acceptable as record drawings unless they have been revised to reflect all field changes. Tracing or reproduction of the Contract Documents shall not be acceptable.

C. Show the following information on the Project Record Drawings:
1. All significant changes in plan, sections, elevations, and details, such as all relocation, or changes in ductwork and piping.

2. All final locations of controls and final arrangement of electric circuits and any significant changes made in design as a result of change order or job conditions.
3. Final location and arrangement of all mechanical equipment.

D. All underground utilities/piping installed as part of this project shall be surveyed by a land surveyor licensed in the State. This shall include underground geothermal piping mains, vaults and vertical bore locations. The survey shall include actual pipe depths to top of pipe every 100 feet in length. The survey shall also include benchmarks dimensions relative to above grade, fixed structures.

E. Provide AutoCAD Version 2017 or later files, or Revit models digitally or on flash drive of all Project Record Drawings.

1.11 OPERATING AND MAINTENANCE MANUALS

A. Submittals of operation and maintenance manuals shall be in accordance with General Conditions and as herein specified.

B. Prepare and deliver to the Engineer, 3 complete sets of operating and maintenance manuals for all equipment listed in the Equipment Schedules and when specified by the Section in which the equipment is furnished. Provide all information pertinent to the equipment for preventive maintenance and for replacement of all expendable components. Manuals shall refer only to the actual equipment provided. All reference to alternative equipment shall be deleted. All such literature shall be bound in 3 new standard 3-ring binders and shall be submitted to the Engineer, along with an electronic (PDF) version.

C. Include the items listed below and features as may be recommended by the manufacturers.
1. Catalog information of the unit installed.
2. Capacity and installation details.
3. Wiring diagrams of electrical components.
4. Special valves and control devices.
5. Complete list of parts with reordering numbers.
6. All points requiring lubrication, lubrication frequency and type of lubricant.
7. Operating pressure and temperatures.
8. Design pressures and temperatures.
9. Relief devices and settings.
10. Electrical characteristics of all motors.
11. Operating curves of pumps and fans.
12. Recommended spare parts list.
13. Warranty Information.

D. Prepare operating instructions, complete and explicit, including instructions for start-up, operating, and stopping. Underscore and emphasize critical points of operations and hazardous limit.

E. Items which also must be included are make-up air units, coils, filters, unit heaters, heating and HVAC components, fans, motors, pumps, temperature control systems with a description of the sequence control, vibration isolation, etc.

F. Include flow charts and wiring programs in the manuals indicating valve locations and control devices. Also include parts lists to be used for ordering replacement and repair parts.

G. Arrange information in an orderly manner in accordance with the numbering system used for the project specification. Include a table of contents for each manual.

H. Manual covers shall include the name of the project.

1.12 DELIVERY, STORAGE AND HANDLING

A. Refer to the General Conditions, Standard Specifications and as specified in each individual section.

1.13 WARRANTY

A. Except where otherwise specifically included in individual Sections, all mechanical systems shall be provided with the guarantees as follows.

B. Guarantee all mechanical systems, equipment, materials, and workmanship to be free from defect for a period of 1 year from the date of final acceptance of the Work. Replace or repair in an approved manner any Work which may prove defective or not in compliance with the Contract Documents without additional cost to the Owner and without interference with the Owner's operation. There shall be a mandatory walk thru at 10 months to ensure all equipment/materials are performing as required.

C. Deliver to the Architect/Engineer 3 copies of all manufacturer's or equipment suppliers' warranties as part of the O&M manuals.

D. Make all adjustments required to ensure operation of the various systems in accordance with the intent of the Drawings and Specifications.

E. It is specifically understood that all adjustments to ensure the proper operation of the systems shall cover a period of 12 months following acceptance of the Work, and the Contractors and/or their suppliers shall make all such adjustments required during this period without delay and without additional cost to the Owner.

1.14 TESTING, ADJUSTING AND BALANCING

A. This contractor shall employ services of an independent firm to perform testing, adjusting and balancing.

B. The independent firm will perform services specified in related section.

C. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.

D. Test Pressures: Lines shall be tested according to the following schedule:

Line	Test Medium	Minimum Pressure	Minimum Time	Remarks
Geothermal Water	Water	125 lb.	24 Hours	No Drop
Condensate	Water	125 lb.	24 Hours	No Drop

1.15 OPERATING INSTRUCTIONS TO OWNER

A. Contractor shall furnish Architect/Engineer with a written statement from the Owner certifying acceptance of all the equipment, data and instructions of operation. Architect/Engineer will not approve the request for final payment until this certificate has been submitted.

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPLIED BY CONTRACTOR

A. Contractor furnishing an item of equipment is responsible for the proper handling, setting, installation, start-up and initial operation.

B. If Contractor is unfamiliar with the proper start-up and adjustment procedure of any equipment or system furnished by him/her, he/she shall include the services of a qualified representative of the manufacturer or vendor to provide start-up assistance and for instruction of the Owner's personnel.

C. Contractor shall include all necessary allowances to ensure that all equipment and systems furnished will be serviced as required during the guarantee period.

D. When a manufacturer offers an extended warranty at additional cost, such extended warranty shall be included as alternate.

2.2 NOISE AND VIBRATION CONTROL

A. Contractor shall make provisions in the installation of the Work that noises or vibrations will not be transmitted through foundations, floors, walls, columns, ducts and piping, so as to be objectionable in any manner. All equipment provided shall be selected and installed with this in view. If any equipment exceeds reasonable requirements as to quietness of operation and freedom from vibration when operating under continuous maximum demands, it shall be altered or replaced.

B. Furnish and install vibration eliminators and isolation equipment for equipment, motors, and pumps, as indicated on the Drawings, and as specified in related section.

C. The isolation and vibration eliminator manufacturer and Contractor shall be responsible for the selection of the proper units for their loadings, quantities, and each shall guarantee that each and every installation and their application shall have a vibration efficiency of 95% or greater. As a minimum, provide types of vibration eliminators as indicated on the Drawings and specified in related section.

D. Submit shop drawings to the Architect/Engineer for review of all isolation equipment with dimensions and other data as recommended and prepared by the isolation equipment manufacturer.

2.3 GUARDS

A. All belts, pulleys, chains, gears, couplings, projecting set screws, key and other rotating parts shall be fully enclosed and properly guarded.

B. Guards shall be constructed of not less than 1-inch x 1-inch x 1/8-inch structural steel angles and 1/2-inch diamond mesh enclosure or equally suitable enclosure, all of hot-dipped galvanized fabrication.

C. Guards shall be secured to the driven machines or to foundations of floors by heavy galvanized structural angle supports and anchor bolts. Braces or supports secured to motors will not be permitted and braces and/or supports must not "bridge" the sound and vibration isolators.

D. Guards shall be designed with adequate provision for movement of motor required to adjust belt tension. Means shall also be provided to permit lubrication, use of speed counters and other maintenance and testing operation with guard in place.

2.4 MAINTENANCE MATERIALS, SERVICE AND SPARE PARTS

A. This contractor shall be responsible for continued maintenance of all equipment furnished under this contract. This contractor shall, at the time of Owner acceptance, provide the Facilities planning Office with a report detailing the following information:
1. Dates equipment arrived at the job site.
2. Installation date.
3. Dates of maintenance at start-up and at periodic maintenance.
4. Dates of lubrication changes as applicable and specific name, manufacturer and type of lubrication.

B. Refer to the General Conditions and to the individual Sections for additional requirements.

PART 3 - EXECUTION

3.1 SAFETY PRECAUTIONS DURING INSTALLATION

A. Contractor shall take all measures to ensure safe installation of all Work and to prevent injury to persons or damage to property in compliance with OSHA and all applicable regulations.

B. Contractor shall erect whatever scaffolds, platforms, supports, or other required construction to safely protect his/her own workers and other persons at the site.

C. Such scaffolds, platforms, etc., shall be designed and constructed by Contractor who shall be solely responsible for their adequacy and safety. Engineer, Architect, the Owner, or User is not responsible for ascertaining the adequacy of any temporary structures used or erected by the Contractor.

3.2 INTERRUPTIONS AND TIE-INS

A. Any interruptions and tie-ins to existing systems that are necessary for installation of the new Work shall be performed and completed in coordination with the Owner's representatives. Provide 2 days written notice prior to any tie-in or connection to existing active systems. Any work requiring shut down of systems serving occupied areas shall occur during off hours, unless otherwise scheduled by mutual agreement.

3.3 MODIFICATIONS AND INTERFERENCES

A. Contractor shall carefully check and become familiar with the Architectural, Structural, Electrical and all Mechanical Drawings and Details and make note of all locations where walls, partitions, ceilings, and structural members are called for to be furred or closed-in.

B. Modifications to the arrangement of the piping and ductwork systems may be required to suit structural conditions, or to avoid interference with the Work of other trades. Contractor shall furnish all offsets, additional fittings, etc., as required to meet installation conditions whether detailed on the Drawings or not.

C. Any conflicting information in the Specifications or on the Drawings shall be called to the attention of the Architect/Engineer for clarification before proceeding with fabrication or erection of the parts affected.

3.4 COOPERATION OF CONTRACTORS

A. Each Contractor, in the event of separate contracts in laying out his/her work, shall cooperate with other Contractors on the work so as to avoid any interference with their work. If this is not done, the Architect/Engineer reserves the right to make such changes in the work as are necessary to avoid interferences and such changes will not be considered as cause for additional compensation or extension of time for the Contractor.

3.5 WORK PRIORITY OVER OTHER TRADES

A. Work in cooperation with one another to fit piping and ductwork into structure as job conditions may demand. All final decisions as to right of way and run of pipe, ducts, to be made by the Architect/Engineer. In general, priority is to be arranged as follows:
1. Recessed lighting fixtures.
2. Sheet metal ductwork.
3. Sprinkler heads and sprinkler water lines.
4. Plumbing waste lines, downspouts and vents.
5. Refrigeration lines.
6. Plumbing water lines.
7. Electrical conduit.

3.6 EQUIPMENT PADS

A. Provide four-inch minimum concrete housekeeping pads for all floor mounted equipment.

3.7 ARRANGEMENT AND ALIGNMENT

A. All equipment, ductwork, piping, etc. shall be arranged and aligned in accordance with the Drawings. Elevations, where given, must be held. Floor elevations, where given, are to high points of floor. Dimensions must be held as closely as possible. All dimensions are to be field-checked for accuracy before fabrication.

B. Install all equipment, ductwork, piping, etc. straight and direct as possible, generally forming right angles with, or running parallel with, walls or adjacent ductwork, piping, etc. All ductwork, piping, etc. shall be neatly spaced with risers and drops running plumb and true.

C. Run ductwork, piping, etc. in wall chases, shafts, hung ceilings, recesses, etc., where same are provided. Do not run in floor slab fill unless specifically so noted on Drawings. Ductwork, piping, etc. shall not be covered or closed until testing is completed.

D. Drawings, in general, are made to scale. All dimensions shall be checked in the field by the Contractor before final connections are fabricated.

E. Drawings are, in general, diagrammatic and the exact locations shall be determined by the Contractor from field measurements. The actual arrangement, when erected, shall follow the general locations shown on the Drawings as far as practicable. The installation shall be neat in appearance and convenient to operate.

F. Installations shall be coordinated with other Work to avoid blocking building openings, light fixtures, etc. and shall not interfere with access to valves or equipment. Equipment, ductwork, piping, etc. shall be installed to provide working clearance for operation and maintenance.

3.8 ALIGNMENT OF ROTATING EQUIPMENT

A. All pumps, fans, etc. or similar equipment directly connected to motors by means of flexible couplings must be perfectly aligned after installation by the use of a dial indicator and the Work of alignment must be performed by a craftsman skilled in the Work.

B. Belted equipment shall be aligned so that the grooves of the driver pulley are truly aligned with those of the driven sheave, and the belts must be in the proper tension, free from flutter. In multi-belt drives, all belts must be operated at the same plane. Flutter in any 1 belt will be cause to reject the entire set, as the original installation of belts must be in matched sets.

C. All equipment provided with high-capacity belt drives must be conveniently tagged and so identified for future servicing and replacement of belts.

D. Before any rotating equipment is put in operation for testing purposes, it shall be properly lubricated with lubricants recommended by the manufacturer, and they shall be further lubricated before the equipment is turned over to the Owner.

3.9 CLEARANCES

A. Install ductwork, piping, etc. to provide minimum clearance of at least one (1) inch between extreme projections of piping, flanges, fittings, valves, allowing for insulation, expansion, etc.

3.10 EXPANSION

A. Special attention shall be given to the installation of ductwork, piping, etc. which have an appreciable movement so that they will not hit other ducts, pipes, structural members, etc. under actual operating conditions.

B. Provide flexible connections or expansion compensators where ducts, pipes, etc. cross building expansion joints.

3.11 LOCATION OF VALVES AND PIPING COMPONENTS

A. System components which require observation, operation, or maintenance such as valves, gages, controls, strainers, dirt pockets, cleanouts, unions and flanges, etc., shall be located, whenever possible, so as to be readily accessible. They shall not be concealed in chases or above ceilings without provision for access. Valves which require frequent operation, or which may require emergency operation, and which are 10'-0" from normal working level, should be installed with appropriate provisions such as chain wheels or extension stems.

B. Install all valves with stems in either an upright (preferred) or horizontal position. Control valves shall be installed with top works upward unless specifically shown otherwise.

C. Globe valves should be installed to seat against the direction of flow.

D. Make provisions for draining all low points of all piping systems, whether indicated on the Drawings or not, using a globe or ball valve and iron pipe thread to hose thread adapter with cap. Drains shall not be less than 3/4 inch, subject to sizes indicated on Drawings.

3.12 DRAINAGE AND VENTING

A. Where ducts, pipes, etc. are purposely pitched for drainage or venting, an accurate grade shall be maintained. Lines shall be supported in such a manner as to prevent deflection sufficient to pocket the lines.

3.13 PIPE SIZE DESIGNATIONS

A. All pipe sizes referred to in these Sections should be interpreted as IPS (iron pipe size) unless specifically designated otherwise, such as "O.D." for tubing.

3.14 CUTTING AND PATCHING

A. All cutting, repairing, fitting, and refinishing of in-place construction required for the installation of the Work of a Section, shall be included as part of the Work of that section except as specifically shown on Drawings or hereinafter specified.

B. Work shall be performed by craftsmen skilled in their respective trades.

C. Match existing conditions in color, materials, and texture.

3.15 DUCTWORK PIPE AND EQUIPMENT IDENTIFICATION

A. Piping identification shall be as specified in related section. Equipment identification consistent with the markings on the equipment schedule shall be made following finished painting with paint or stencil letters or numerals as approved by the Architect/Engineer.

3.16 CLEANING - GENERAL AREA

A. Contractor shall assist in maintaining the premises in an orderly fashion at all times, providing continuous clean-up during the construction period. Contractor shall remove all cartons, containers, and crates as soon as the contents have been removed and shall also remove all debris caused by Work as soon as possible. Deposit all discarded materials in a suitable refuse container and prevent these materials from being scattered by the elements. All cartons and debris shall be removed from the premises and site at the sole expense of Contractor.

B. Contractor shall stack all construction materials associated with his/her Work in areas so as to avoid congestion and interference.

C. At the completion of the work, the Contractor shall clean all of his/her work and equipment free from dust and other foreign matter and shall leave the work in good housekeeping condition, in a manner acceptable to the Architect/Engineer.

3.17 WIRING DIAGRAMS

A. Contractors shall provide each piece of electrically connected, controlled, or operated equipment with specific wiring diagrams and instructions. Diagrams and instructions shall not be of a general or typical nature but applicable only to the specific job. The diagrams and instructions used to install the equipment shall be identical to that included in the "Operations and Maintenance Manuals".

3.18 SYSTEM START UP

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify the Architect/Engineer 7 working days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions which may cause damage.

D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer. Check ratings of overload relays for each starter.

E. Verify wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of applicable manufacturer's representative and Contractors' personnel in accordance with manufacturers' instructions.

G. When called for 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.

H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.19 DEMONSTRATION AND INSTRUCTIONS

A. Provide the services of a competent supervisor or technician to instruct the Owner's personnel in the operation of each piece of equipment/systems installed as specified in the individual sections. Include not less than the time listed for each of the systems. Where required by the individual section of the specifications, provide the services of factory trained specialists to instruct the Owner's personnel in the operation of the equipment/system so specified.

B. Demonstrate operation and maintenance of products to Owner's personnel, 2 weeks prior to date of completion. Provide an over/outline of the purpose and operation of all equipment installed under this contract.

C. Demonstrate Project equipment and instruct in a classroom environment for up to 10 people, located at the project site and instructed by a qualified manufacturer's representative who is knowledgeable about the Project. Provide documents for all attendees.

D. For equipment or systems requiring seasonal operation, perform demonstration for other season within 6 months.

E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual in detail with the Owner's personnel in detail to explain all aspects of operation and maintenance. Training shall include review of temperature control drawings and schematics.

F. Demonstrate start-up, operation, control, adjustment, normal & unoccupied operations, system trouble-shooting, step by step procedure for determining the source of problems on the system level, component trouble-shooting description of diagnostic procedures for determining the source of the problems on the component level, servicing & maintenance instructions of required procedures for weekly, monthly, and annual preventive checks and timely repairs, sources of spare parts and special tools, and shut-down of each item of equipment at agreed time at designated location.

G. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

H. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

I. Training shall include a question and answer period.

J. Training shall include special requirements of tenants for equipment's function.

K. Training shall include any special issues to maintain warranties.

L. Training shall include relevant health and safety issues and concerns, and special safety features.

M. Training shall include Integral Controls Programming, trouble shooting, alarms, manual operation, and interface with Integral Controls.

N. Training shall include Building Automation Controls Programming, trouble shooting, alarms, manual operation, and interface with Integral Controls.

O. Training shall include interaction with other systems, and operation during power outage and fire.

P. Training shall include common trouble shooting issues and methods, control system warnings and error messages including using the control system for diagnosis.

Q. Digitally record all instructional sessions and demonstrations. Provide two flash drives, labeled with all pertinent information to identify specific equipment or systems, and include in the O & M's.

3.20 LUBRICATION

A. During the commissioning process and prior to testing, all equipment shall be properly lubricated in accordance with the manufacturer's instructions. One set of tools necessary for lubrication shall be provided by this Contractor.

B. Except for small electrical motors which, under NEMA Standards, are equipped with lifetime lubrication, all bearings on large motors and mechanical equipment shall be equipped with lubrication fittings at all service points, accessibly located. Oil fill and drain line extensions shall be provided where necessary for convenient servicing of equipment.

3.21 TESTING

A. Testing all equipment/systems installed shall be the responsibility of the trade installing the Work under the supervision of an Engineer employed by the Contractor except as specified. The Owner shall employ services of an independent firm to perform testing, adjusting and balancing:
   1. The independent firm will perform services specified in related section.
   2. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.

B. Furnish all gauges, instruments, test equipment and personnel required for the tests. Adjust all equipment to perform with the least possible noise and vibration consistent with its duty. Quietness of operation of all equipment is a requirement. Any equipment producing noise that is abnormal, in the opinion of the Architect/Engineer, shall be repaired or removed and replaced with satisfactory equipment at no additional expense.

C. Operate the system and make all adjustments in control and equipment and complete necessary balancing to deliver not less than the air or fluid quantities shown on the Drawings for each equipment item.

3.22 TOOLS

A. On completion of the Work, the Contractor shall furnish and deliver to the Owner any special tools and instrumentation that may be required for the proper servicing or routine testing of any equipment furnished under this Contract.

END OF SECTION 23 0500

SECTION 230514 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements; and Division 23 Section "General Mechanical Requirements."

1.2 DESCRIPTION OF WORK

A. Provide variable frequency drives (VFDs) as specified herein.

B. The VFD shall consist of a pulse-width-modulating (PWM) inverter for positive speed control for standard NEMA design B induction motors used in HVAC applications. The VFDs will be manufactured by Danfoss, Toshiba Inc., Yaskawa, Square D, ABB, or Cutler Hammer, and shall be UL-listed.

1.3 SUBMITTALS

A. Shop Drawings: Fabrication drawings indicating materials of construction, unit configurations, dimensions, field connection details, support details and installation details.

B. Product Data
1. All product items specified.
2. Manufacturer's literature and cut sheets.
3. Wiring diagrams.
4. Weights.
5. Temperature/ambient requirements.
6. Noise and sound data.

C. Samples: Not required for A/E review.

D. Contract Close-Out Information
1. Operating and maintenance data.
2. Training video.
3. Warranties.

1.4 WARRANTY

A. The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory-certified service technician. Start-up services shall include checking for verification of proper operation and installation for the VFD, its option, its interface wiring to the building automation system, and programming of any critical frequency rejection points.

B. The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts and labor.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. VFD systems shall be microprocessor-based and fully transistorized with a conservatively rated 3-phase, full-wave diode bridge input and a pwm sine-coded output waveform. The input diode bridge shall be protected against line noise by a total harmonic distortion below 35% fundamental drive current. This can be accomplished through reduced harmonic technology (RHT) or 5% line reactors. The output transistors must be of the insulated gate bipolar transistor (IGBT) type to facilitate noiseless motor operation. The VFDs shall be tested and rated for a minimum of a 20-year mean time between failure (MTBF). Provide manufacturer's typical test results or calculations with submittal to verify MTBF.

B. To minimize electrical and acoustical noise, and to eliminate low-speed cogging, a minimum switching frequency of 15 khz shall be used. The VFD shall not "cog" at frequencies above 1.5 hz. There shall be no sudden frequency shifts as the output frequency is varied between 1.5 and 60hz.

C. The VFDs input displacement power factor shall be 0.98 or better over the entire operating frequency and load range. Efficiency shall be measured at 96% minimum at rated load. Provide manufacturer's typical test results or calculations with submittal to verify efficiency and power factor.

D. All VFDs shall have, but shall not be limited to, the following protective features:
   1. Solid state output ground fault protection shall be provided.
   2. Adaptive electronics motor overload protection shall be provided which shall protect both the motor and the VFD at all frequencies. Electronic thermal overload circuits which only properly protect the motor at full speed shall not be acceptable. The VFD shall sense the load and speed and shall recalibrate the thermal trip curve to ensure low-speed motor protection. The initial trip point shall be adjustable from at least 40% of the VFD continuous rating to account for motor magnetizing current.
   3. Input surge protection shall be performed by MOVs (metal oxide varistors) in accordance with ANSI Specification C62.41.1 and C62.41.2.

E. Opto-coupled isolated control inputs shall be provided. The motor speed shall be directly proportional, or inversely proportional to 0-10 VDC, 4-20 ma, and variable resistance signals. In addition, the VFD shall have independent settings adjustable on the fly for input reference offset (positive and negative) and gain to facilitate signal setting/matching.

F. VFD operation options shall be programmable, and shall include, at a minimum, the following functions:
   1. User-definable speed upon lost reference signal. Drive to indicate fault upon lost signal.
   2. The standard protocol shall be BACnet. Each individual drive shall have the protocol in the base VFD. The use of third-party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.
   3. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all

analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected the ability to change the PID set point. The DDC system shall also be able to monitor if the motor is running in the VFD mode over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

4. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.

G. The VFD shall provide the following operational features:
   1. "Speed search" transfer. The VFD shall have the ability to start from bypass or fault trip into a spinning load from 100% forward to 100% reverse rotation without stopping the motor or creating a fault condition. The VFD shall match the motor's speed and then drive the motor to its proper speed reference.
   2. Programmable current limit.
   3. Programmable, "intelligent" auto-restart function. Intelligent auto-restart precludes any attempt to restart in the event of trips typically indicative of component failure.
   4. Drive must have power loss ride-through capability, for units 5 HP and larger. In the event of a loss of three-phase power lasting 2 seconds or less, the VFD must have the ability to regain operation without nuisance trips.
   5. Critical Frequency Rejection Points: Drives shall be capable of programming up to 3 frequency rejection points to protect the driven equipment from continuous operation at harmful resonance frequencies.
   6. The following fault conditions shall cause the VFD to shut down without damage and shall be annunciated via alpha-numeric fault diagnostic (remote annunciation shall be available with a form 'c' fault contact):
      a. Overload (blow fuse any or all legs/loss of phase)
      b. Instantaneous over current trip (short circuit)
      c. DC bus overvoltage
      d. DC bus under voltage, phase loss protection
      e. Excessive ambient, VFD heat sink over temperature
      f. Ground fault input
      g. Internally diagnosed, control failure
      h. Motor thermal overload
      i. VFD thermal overload
      j. Programmable "shear pin" current trip

2.2 PROGRAMMING/OPERATOR STATION

A. Include alpha-numeric display of frequency reference, output frequency, output current (accurate +/-3%, regardless of output frequency), output voltage, DC bus voltage, output power (kW), input terminal status, output thermal status, LED lamp check, and EEPROM number.

B. Alpha-numeric display of faults. Up to 4 sequential faults shall be retained in non-volatile memory (maintained even after removal of input power). All system information (voltage

levels, current levels, etc.) shall be stored for the previous 3 seconds before the last fault in 160 nsec intervals to aid in diagnostics.

C. VFD systems located outdoors shall be mounted in a NEMA 3R stainless steel enclosure. VFD systems located in indoor wet/damp rooms or indoor rooms with water systems such as chiller or boiler rooms shall be mounted in a NEMA 12 enclosure. VFD systems mounted in indoor dry rooms without water systems shall be mounted in a NEMA 1 enclosure. All enclosures shall be provided with the following additional equipment requirements:
   1. Door-mounted digital operator control station.
   2. Door-interlocked input circuit breaker with flange-mounted pad-lockable operating handle.
   3. Three (3) contactor bypass to fully isolate the VFD. The VFD must be able to be run for testing purposes while the motor is operating in the bypass mode.
   4. Output 3-phase current sensing overload relay to provide motor protection in either the VFD or bypass mode.

D. VFD systems shall be full load tested prior to shipment.

E. DV/DT – All VFDs operating multiple motors are required to have a DV/DT filter. All VFDs operating a single motor with a wire distance of more than 100 feet are also required to have a DV/DT filter. The DV/DT filter will limit the rated voltage rise over time to prevent the breakdown of motor winding insulation and reduce the motor operating temperature. The DV/DT filter can be mounted internally to the VFD enclosure or supplied externally in close proximity to the VFD. If supplied externally, the DV/DT filter shall be mounted in a NEMA enclosure matching the VFD NEMA enclosure type. The DV/DT filter shall be UL listed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed per manufacturer's recommendations.

B. Label all control components to match the control and wiring diagrams.

C. All motors controlled with VFDs shall be provided with a shaft grounding system to electrically insulate bearings to prevent damage due to stay shaft currents.

END OF SECTION 23 0514

SECTION 230523 - VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section includes valves for the following systems:
   1. Geothermal Water.
   2. Makeup Water.
   3. Cooling Coil Condensate Drain Water.

1.3 SUBMITTALS

A. Shop Drawings: Schedule indicating proposed valve for each application.

B. Product Data
   1. Manufacturer's cut sheets and/or literature.
   2. Performance Data

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
   1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
   2. Operating and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

C. ASTM Compliance
   1. ASTM B61 for 200 psi and 300 psi valves with metallic seats.

D. Factory test all Valve Bodies, Shells and Seats per MSS requirements as a minimum.

E. Iron Body Valves
   1. Pressure-Containing Parts: ASTM A126, Grade B.
   2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.

3. Design, Workmanship, Materials, Testing: MSS-SP-70, 71, 85.

F. Butterfly Valves
1. Face-to-Face and End-to-End Dimensions: MSS-SP-67.

G. Valve Stems: ATM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.

H. Valve-End Connections
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B 16.18.
3. Threaded: With threads according to ASME B1.20.1.
4. Grooved: With grooves according to Victaulic published dimensions.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Pressure Casting shall be free of impregnating materials, no welding of iron allowed.

K. Manufacturer's name or trademark and working pressure stamped or cast into body.

L. Valves shall be rated at least 20% over the maximum system working pressure and not less than required for system temperatures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Valve Sizes shall be the same as upstream piping unless otherwise indicated.

B. Valve Bypass and Drain Connections: MSS SP-45.

C. Combination Balancing and Shutoff Valves.
1. Install where shown on Drawings. Valves shall be designed and used only for balancing.
2. Provide a means for connecting to a portable differential pressure meter for readout. A portable pressure gauge, hoses and flow curves shall be provided in a portable test kit.
3. On sizes 2-1/2 inches and larger, valve size, capacity and operating pressure must comply with ASME boiler and pressure vessel code: section IV.
4. Refer to manufacturer's recommendations for upstream and downstream straight piping lengths.

D. Coil Piping Packages/Coil Hook Ups
1. Contractor has the option to use these factory assembled valve packages in lieu of individual valves and ports as shown on the drawings at any terminal unit connections.
2. Shall only be provided on pipes 2 inches and smaller.
3. All components shall be rated for 125 psig working pressure and shall be full-port (full-bore) design.
4. The order and arrangement of components shall be consistent with the Drawings.
5. Each individual component shall meet the specification requirements for components of a field-assembled system.
6. Acceptable manufacturers: Victaulic/Tour Andersson, ITT Bell & Gossett, Flow Design and Griswold.

E. Multi-Purpose (Three-Function Valve)
1. Can be used in lieu of Combination Balancing/Shutoff Valve and Check Valve at Pump Discharge.
2. Triple Duty Valve manufacturer must be the same as pump manufacturer.
3. Horizontal or vertical installation is acceptable; valve may be field convertible for straight or angled position.
4. Valve shall be a ductile iron body, bronze seat disc, with a 302 stainless steel spring.
5. Valve stem shall be made of bronze or 416 stainless steel with seal packing replaceable under pressure.
6. Bronze fitted construction.
7. Valve shall have a memory indicator, pointer and scale.
8. Schrader valve or P/T port metering connections.
9. O-ring sealed valve body shall be EPDM.
10. Replaceable 'soft seat' shall be EPDM.
11. The valve, in the full-open position shall have no more than a 1 psi pressure drop across the valve.
12. Valve shall be constructed with a minimum of 125# working pressure (maximum 250#).
13. Valve shall be available in threaded for 2" and smaller and flanged or grooved end connections in sizes 2-1/2 inches and larger.

2.2 HVAC SYSTEMS (geothermal water, make-up water and cooling coil condensate drain) WITH OPERATING TEMPERATURES UP TO 200 DEG F.

A. Start/Stop Flow; 2 Inches and Smaller
1. Type: 2-piece full port ball. Basis of Design NIBCO T/S-585-66-LF and or T/S-585HP-66_LF
2. SWP Rating: 150 psig (1035 kPa).
3. CWP Rating: 600 psig (4140 kPa).
4. Body Material: Bronze ASTM B 584 Alloy C844.
5. Seal Material: Reinforced PTFE.
6. Ends: Threaded or soldered for copper piping.
7. Ball Material: 316 stainless steel.
8. Stem Material: 316 stainless steel.
9. Operator: Hand lever.

B. Start/Stop Flow; 2-1/2 Inches and Larger
1. Type: Butterfly. Basis of Design NIBCO LD-2000-3/5
2. Minimum ANSI Class: 150 WOG.
3. Body Material: Ductile iron.
4. Seat Material: EPDM.
5. Ends: Full lug flange.
6. Disc Material: Aluminum bronze.
7. Stem Material: 416 stainless steel.
8. Operator: 10-position hand lever for less than 6 inches, gear actuator for 6 inches and larger.
9. Other: Valves and Seats shall be rated for 150 psi shutoff during dead-end service, without downstream piping or flange.
10. Option for grooved piping systems: 300 psi CWP suitable for bi-directional and dead-end service at full rated pressure. Body shall be grooved end ductile iron conforming to ASTM A536. Disc shall be offset from the stem centerline to allow full 360 degree

seating. Seat shall be pressure responsive EPDM. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat.
a. 2-1/2" through 12": Victaulic Style 300 MasterSeal™ or NIBCO GD-4765-N
b. 14" through 24": Victaulic AGS Style W761 300 MasterSeal™.

C. Prevent Back Flow; 2 Inches and Smaller
1. Type: Check – Horizontal swing or vertical lift.
2. Minimum ANSI Class: 125 SWP (200 WOG). Basis of Design NIBCO T/S-413Y-LF or T/S-480-Y-LF
3. Body Material: Bronze (ASTM B 62).
4. Disc Material: Reinforced PTFE.
5. Ends: Threaded or Soldered for copper piping.
6. Cap: Threaded.

D. Prevent Back Flow; 2-1/2 Inches and Larger
1. Type: Swing check.
2. Minimum ANSI Class: 125 SWP (200 WOG).
3. Body Material: Cast iron (ASTM A 126).
4. Disc Material: Cast iron (ASTM A 126).
5. Seat Ring Material: Bronze (ASTM B 62).
6. Ends: Flanged.
7. Cap: Bolted.
8. Option for grooved piping systems: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi.
a. 2-1/2" through 12": Victaulic Series 716 (Or Series 779 with Venturi taps).
b. 14" through 24": Victaulic AGS Style W715.

E. Prevent Back Flow; 2-1/2 Inches and Larger
1. Type: Globe body silent check valve.
2. Minimum ANSI Class: 125 SWP.
3. Body Material: Cast iron (ASTM A 48, Class 35).
4. Disc Material: Cast iron with bronze face rings.
5. Ends: Flanged or wafer.
6. Seat Material: Bronze (ASTM B584).
7. Plug Material: Bronze (ASTM B584).
8. Spring Material: Stainless steel T304 (ASTM A 276).

F. Acceptable Manufacturers: Milwaukee, Hammond, Crane, NIBCO, DeZurik, Watts, Tyco, Victaulic or Mueller.

G. Regulate/Balance Flow; 2 Inches and Smaller
1. Type: Combination balancing and shutoff valve (calibrated Y-Pattern globe) Basis of Design NIBCO T/S-1810-LF.
2. Minimum Pressure: 240 psig.
3. Body Material: Non-Ferrous (DZR) Brass alloy.
a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.
4. Ends: Flanged, threaded or soldered for copper piping.
5. Seat Seal Material: EPDM.

6. Stem and Seat Material: Non-Ferrous (DZR) Brass alloy.
   a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.
7. Operator: 4-Turn hand wheel with hidden memory stop.
8. NOTE: Ball type valves not acceptable as balancing device.

H. Regulate/Balance Flow; 2-1/2 Inches and Larger
1. Type: Combination balancing and shutoff valve (venturi globe type). Basis of Design NIBCO F-721-A.
2. Minimum Pressure: 300 psi.
3. Body Material: Ductile iron.
4. Ends: Flanged, grooved or threaded.
5. Seat Seal Material: EPDM.
6. Stem and Seat Material: Non-Ferrous (DZR) Brass alloy.
   a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.
7. Operator: Multi-turn handwheel with hidden memory stop.
8. NOTE: Butterfly type valves not acceptable as balancing device.

I. Acceptable Combination Balancing and Shutoff Valves are: Victaulic/Tour Andersson, Armstrong, ITT Bell & Gossett, Griswold, Taco or Flow Design.

PART 3 - EXECUTION

3.1 STORAGE, HANDLING, AND EXAMINATION

A. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

B. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

C. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

D. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

E. Examine threads on valve and mating pipe for form and cleanliness.

F. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

G. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves at locations shown on the Drawings, per the Specifications and in accordance with manufacturer's written instructions.

B. Locate valves for easy access and provide separate support where necessary.

C. Service/isolation valve shall be provided at every piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown and minimal disruption to the piping service.

D. Install Combination Balancing and Shutoff Valves at each branch connection to return main.

E. Install Start/Stop flow valve for isolation at each branch connection to supply main.

F. Install check valves at each pump discharge and elsewhere as required to control flow direction.

G. All check valves should be installed in a location that has smooth and laminar flow conditions.

H. For swing type check valves, locate valve a minimum of 10 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 5 pipe diameters downstream of valve.

I. For silent type check valves, locate valve a minimum of 4 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 3 pipe diameters downstream of valve.

J. Install valves in horizontal piping with the hand wheel and stem at or above center of pipe.

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

L. Valves installed in copper lines shall be provided with screwed or flanged adapters with a union installed downstream and within 12 inches of the valve.

M. Install chainwheels on operators for all valves located with the lowest portion of its handwheel or lever at 10 feet or more above finished floor. Extend chains to 5 feet above finished floor.

N. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

O. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 23 0523

SECTION 230529 - HANGERS, SLEEVES, AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to: Pipe hanger and supports, Pipe and equipment anchors and Pipe sleeves.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

B. SMACNA.

C. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, so as to maintain compliance and uniformity with SMACNA's engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

1.4 SUBMITTALS

A. Shop Drawings: Miscellaneous steel layout. Indicate all point loads where miscellaneous steel is supported by structural members, Brace spacing, layout, connection method and details.

B. Product Data: Catalog cuts and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Operating and maintenance data, Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers: Elcen Metal Products Co., B-Line Systems Inc., Carpenter and Paterson Inc., Anvil.

B. Concrete Anchors: Phillips, Hilti, and Powers.

C. Insulated Pipe Supports: Pipe Shields Inc., Anvil, Power Piping.

D. Pipe and Equipment Anchors: Shop-fabricated, Field-fabricated.

E. Sleeves: Shamrock Industries, "Crete-sleeve" plastic hole forms, Proset Systems Inc., "Proset" fire-safe pipe penetrations, Shop for field fabricated.

F. Sleeves, Pre-Manufactured Fire and Smoke Wall Barrier: Pipe Shields, Inc.

2.2 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Cadmium plated carbon steel, adjustable swivel split ring. Use PVC coated or copper plated for copper piping.

B. Hangers for Pipe Sizes 2 to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Carbon steel, adjustable, clevis type. Use copper plated for copper piping.

C. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.

D. Hangers for piping that gets insulated shall be sized to allow insulation to be continuous through hangers.

E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods; cast iron roll and stand for hot pipe sizes 6 inches and over.

F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

G. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll for hot pipe sizes 6 inches and over.

H. Vertical Support: Steel riser clamp.

I. Floor Support for Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.

J. Shield for Insulation Piping 16 gage galvanized steel shield over minimum 12 inches long at pipe support. 360-degree insulated saddle system consisting of a factory assembled 2.5 PCF density 25/50 Flame/Smoke rated phenolic foam pipe insulation with .02 perm rated vapor retender film with self-sealing lap. Buckaroos model 255OFS or equal.

2.3 HANGER RODS AND ATTACHMENTS

A. Steel Hanger Rods: Threaded both ends, threaded one end, and continuous threaded. Use cadmium plated rods where unconcealed or exposed to the elements.

B. Minimum pipe hanger rod sizes are as follows:

Pipe Size	Rod Diameter
Up to 2 Inches	3/8 Inch
2-1/2 Inches & 3 Inches	1/2 Inch
4 Inches	5/8 Inch
6 Inches	3/4 Inch
8 Inches to 12 Inches	7/8 Inch
14 Inches to 18 Inches	1 Inch
20 Inches to 30 Inches	1-1/4 Inch

C. Beam Clamps (up to 8-inch diameter pipe): Top beam clamp, steel jaw, hook rod with nut and spring washer steel eye-bolt. C-clamps by themselves are expressly prohibited unless otherwise approved by Structural Engineer

2.4 INSERTS

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

2.5 PIPE SLEEVES AND SEALANTS

A. Sleeves – General: Sleeve all piping passing through walls, floors, roofs, foundations, footings and grade beams sufficient to allow free movement of piping. Box out openings larger than 14 inch diameter.

B. Sleeves, Steel Pipes: Use in following locations:
1. Fire-rated and smoke-rated construction.
2. Structural steel members (when approved by A/E).
3. Floors: Galvanized.
4. Concrete walls.
5. Mechanical rooms, tunnels, and stairwells.
6. Polyethylene hole forms (Crete-Sleeve): Optional use in poured concrete walls and floors.

C. Sleeves for Future Work: Same as for this work.

D. Sleeves in Other Locations: As detailed. If not detailed, use 18 ga galvanized sheet metal or 24 ga spiral duct.

E. Sleeves for Plastic Piping
1. Provide pipe sleeves for all plastic-type piping (PVC, CPVC and polypropylene) at fire-rated assembly and floor slab penetrations.
2. Size sleeves per following schedule:

Pipe Size (In.)	Sleeve Size (In.)	Extension Beyond Barrier (Ft.)
1 or less	3	2
1-1/4 to 2	4	2
3	5	3

Pipe Size (In.)	Sleeve Size (In.)	Extension Beyond Barrier (Ft.)
4	6	4

3. Extend sleeve listed distance beyond wall or floor on both sides.
4. Insulate plastic pipe with minimum 1 inch thick calcium silicate or 2400 deg F aluminasilica within sleeve length.

F. Sleeves, pre-manufactured fire and smoke wall barrier: Optional, similar to Pipe Shields, Inc.
1. Bare Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
2. Insulated Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
   a. Insulated chilled water and DX lines: Type CS-CW.
   b. Other insulated pipes: Type CS.
3. Plastic Pipe through Fire Walls and Floors: Type WFB with 1-inch-thick calcium silicate insulation encased in metal sleeve extension 2 ft. either side of fire-rated walls or floor.

G. Sleeve Sizes
1. Length: Ends flush with finished surfaces.
2. Diameter
   a. Minimum 3 inch.
   b. Minimum 1 inch larger than pipe and pipe insulation.
   c. In concrete, 1-1/2 inch larger than pipe.
   d. Diameter suitable for construction tolerances and to receive sealant, when indicated.

H. Sealants: Seal annular space around piping.
1. For fire- and smoke-rated floors, walls and partitions: Use UL-listed firestopping material that maintains fire-rated wall and floor integrity. Provide proper material for each typical application as described by manufacturer.
2. Acceptable Manufacturers: Dow Corning "Fire Stop", Nelson "Flameseal", 3M "Fire Barrier", Pipe Shields Inc., Model WFB, DFB, or QDFB Series, Proset Systems.
3. For Non-Rated Walls and Partitions: Use mineral or glass fiber insulation.
4. For Exterior and Foundation Walls: Use synthetic rubber seals, "Link-Seal" waterproof material or system.

PART 3 - EXECUTION

3.1 GENERAL

A. Structural Considerations
1. Steel or concrete roof/floor system, including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.
2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe Hanger Loading."
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers to bottom of concrete filled floor deck, except by permission of A/E. Permission from A/E will only be provided when required due to construction schedule timing issues. If permission from A/E is provided, Powers BANG-IT concrete insert or approved equal shall be used.
5. Attach hangers to beams whenever possible.

B. Install piping systems with approved hangers and supports to prevent sagging, warping and vibration of piping systems. Install pipe hangers and supports to allow for expansion, contraction, and drainage of piping. Place hangers and supports close to valves, vertical riser drops, heavy equipment, specialties, and each piping change of direction. At first elbow of equipment run out piping risers and horizontal piping within 10 feet of all circulating base mounted pumps having 4-inch or larger piping connections, shall have piping at same supported with flexible spring hangers.

C. Connect hanger rods to approved "I" beams or channel clamps, concrete inserts or expansion shields. Provide all concrete inserts and structural members required for the proper support of the piping systems with proper approved distribution of weight.

D. Do not weld to structural steel without special permission of the A/E. Do not use wooden plugs for any form of fastening.

E. Space pipe hangers for horizontal piping as indicated, unless otherwise directed. Provide pipe hangers with the minimum rod sizes shown, complete with full length machined threads, and adjusting and lock nuts.

F. Run piping substantially as shown on the Drawings. Run pipe as directly as possible, avoiding unnecessary offsets and interferences, maintaining maximum headroom and concealed in all rooms or areas, except mechanical equipment rooms, unless otherwise noted. Coordinate exact locations of mains, risers and runouts in the field with the various Trade Contractors and the A/E.

G. Arrange pipe lines to give ample room for pipe insulation. Run piping parallel to or at right angles with the lines of the building.

H. Assemble and install piping without undue strain and stress and with provision for expansion, contraction and structural settlement. Do not cut or notch structural members unless adequate provision is made with the approval of the A/E. Anchors shall be approved by the A/E before they are used.

3.2 PIPE HANGERS AND SUPPORTS

A. For standard steel and copper piping, locate hangers at each change of direction as well as within remaining lengths spaced at or within following maximum limits:

Pipe Diameter	Steel Liquid	Steel Vapor	Copper Liquid	Copper Vapor
1/2 - 1 inch	7 ft.	8 ft.	5 ft.	6 ft.
1-1/4 - 2 inch	7 ft.	9 ft.	7 ft.	9 ft.
2-1/2 - 3 inch	11 ft.	12 ft.	9 ft.	12 ft.
3-1/2 - 4 inch	12 ft.	12 ft.	11 ft.	12 ft.
5 - 6 inch	12 ft.	12 ft.	12 ft.	12 ft.
8 - 30 inch	12 ft.	12 ft.	12 ft.	12 ft.

B. For Schedule 40 or Schedule 80 PVC piping, locate hangers at each change of direction and space at or within the following maximum limits:

Schedule 40 or 80 PVC		
Pipe Diameter	Liquid	Vapor
1/2 - 1 inch	3 Ft.	3 Ft.
1-1/4 - 2 inch	3 Ft.	3 Ft.
2-1/2 - 3 inch	6 Ft.	6 Ft.
3-1/2 - 4 inch	7 Ft.	7 Ft.
5 - 6 inch	8 Ft.	8 Ft.
8 - 14 inch	12 Ft.	12 Ft.

C. Provide a hanger within 1 foot or less of each horizontal elbow and valves that are above 3 inches in size. If spacing between horizontal elbows (or plugged tees used as elbows) is less than 6 feet, provide only 1 hanger located between the elbows. No hanger size or requirements shall ever be less than the minimum recommended by the Mechanical Contractor's Association of America, Inc.

D. For piping of other materials, space hangers according to manufacturer's recommendations.

E. Pipe Hanger Loading
1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 inch	610 lb.
1/2 inch	1,130 lb.
5/8 inch	1,810 lb.
3/4 inch	2,710 lb.

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

F. Trapeze Hangers: Suspend trapeze hangers from concrete inserts of approved structural clips. Construct trapeze hangers of galvanized angle iron, channels or other structural shapes with flat surfaces for point of support.

G. Vertical Pipe Supports: Support all vertical pipe runs in pipe chases at base of riser. Support pipes for lateral movement with clamps or brackets.

H. Concrete Inserts: Provide individual or continuous slot concrete inserts for use with hangers for piping and equipment exposed in finished areas, and as required. Provide concrete inserts in time for installation in concrete.

3.3 DUCT HANGERS

A. Install necessary hanger rods and angle iron support brackets to properly support, ductwork, insulation, reinforcing, and external loads. Fiction clamps are excluded as upper attachment devices.

B. Max spacing of supports to be as follows:

Rectangular Duct

1/2 x Duct Perimeter (Inches)	Rod Diameter (Inches)	Spacing (Feet)
Less than 72	3/8	10
72 to 120	3/8	8
120-192	1/2	5

Round Ducts

Duct Perimeter (Inches)	Rod Diameter (Inches)	Spacing (Feet)
Through 24	1/4	12
25 through 36	3/8	12
37 through 50	1/2	12

1. Use a pair of rods, 1 on each side of ductwork. Rods to be uncoated, hot-rolled steel.
2. OPTION: 1 inch wide sheet metal straps may be used on sizes up to 22 inches wide (or 22 inches in diameter), 1 sheet metal gauge (minimum) thicker than ductwork being supported.

3.4 ANCHORS

A. All connections to the structure shall be sized according to actual applied load plus any seismic vertical component increase.

B. Pipe Anchors: Provide as indicated and required to permit complete installation of system. Do not anchor piping to plaster or gypsum wallboard partition walls. Provide anchoring devices at locations indicated. Do not use powder driven fasteners, expansion nails, or friction spring clamps.

3.5 SLEEVES

A. Coordinate location of any opening in structural systems with A/E and other trade contractors.

B. Maintain rating of fire- and smoke-rated construction.

C. Set sleeves plumb or level, in proper position, tightly fitted into the work.

D. Set all sleeves with ends flush with finished wall and ceiling surfaces.

E. Seal around all pipes and use firestopping for all mechanical penetrations through floor slabs, fire rated walls and partitions, and at each floor level in vertical mechanical service shafts. Install firestopping as described in manufacturer's installation instructions.

F. Seal around all sleeves.

G. Fill openings made by others for piping penetrations, with same construction as work opening is in, or construction of equivalent fire or smoke rating.

3.6 MISCELLANEOUS STEEL

A. Piping Contractor (or Heating Contractor, as applicable) to provide all miscellaneous steel as required to accommodate pipe supports and hangers.

B. Provide Shop Drawings detailing miscellaneous steel layout and connection to structural members. Indicate all point loads where miscellaneous steel is supported by structural members.

C. All miscellaneous steel to be galvanized steel. Repair galvanized steel at field cuts and connections.

END OF SECTION 23 0529

SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Piping identification.
   2. Valve identification.
   3. Equipment identification.

1.3 QUALITY ASSURANCE

A. Piping System Identification: ANSI A13.1-2015, "Scheme for the Identification of Piping Systems."

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Manufacturer's cut sheets and/or literature.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Valve chart showing valve numbers, type, and location.

F. The naming/numbering/tagging convention used must be a coordinated effort between the Mechanical Contractor, Controls Contractor, Owner, and A/E and must be approved by all parties prior to implementation. The naming/numbering/tagging convention must be consistent and reflected through the building automation control system, charts, diagrams, tagging and O&M manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe, Valve, and Equipment Markers
   1. Craftmark Identification Systems.
   2. W. H. Brady Co.
   3. EMED Company, Inc.
   4. Kolbi Industries, Inc.
   5. 3M Co.
   6. Seton Name Plate Corp.

2.2 PIPE MARKERS

A. Conform to ANSI A13.1-2015.
1. Pressure-sensitive vinyl (self-sticking) material.
2. Mechanically Fastened Type: Snap-on or strap-on.
a. For dirty greasy, oily pipe where pressure-sensitive markers may not perform satisfactorily.
3. Provide with direction of flow arrows.
4. Size of Letters Legend

Outside Diameter of Pipe or Pipe Covering	Length of Color Field	Size of Letters and Arrows
3/4 to 1-1/4 inch	8 inch	1/2 inch
1-1/2 to 2 inch	8 inch	3/4 inch
2-1/2 to 6 inch	12 inch	1-1/4 inch
8 to 10 inch	24 inch	2-1/2 inch
Over 10 inch	32 inch	3-1/2 inch

2.3 VALVE TAGS

A. Brass or Anodized Aluminum Type
1. Brass: Minimum 19 ga, polished, 1-1/2-inch diameter with following lettering:
a. Service: 1/4-inch stamped black filled letters.
b. Valve numbers: 1/2-inch stamped black filled letters.
2. Aluminum: 2-inch diameter, 0.032-inch thick, with following lettering:
a. Service: 1/4-inch engraved letters.
b. Valve numbers: 1/2-inch engraved letters.

B. Valve Tag Fasteners: 4-ply 0.018 copper or monel wire meter seals, brass "S" hooks or No. 16 brass jack chain.

2.4 EQUIPMENT NAME PLATES

A. 1/16-inch rigid plastic "Setonply," "Emedolite," or bakelite with 4 edges beveled, or engraved aluminum with black enamel background and natural aluminum border and letters.
1. Two 3/8-inch mounting holes.
2. Lettering size: Minimum 1/2 inch high.
3. Fasteners: Commercial quality, rust-resisting nuts and bolts with backwashers and self-tapping screws or rivets.

2.5 CHART AND DIAGRAM FRAMES

A. Extruded aluminum with plexiglass or glass windows.

PART 3 - EXECUTION

3.1 VALVE AND EQUIPMENT IDENTIFICATION

A. The naming/numbering/tagging convention used must be a coordinated effort between the Mechanical Contractor, Controls Contractor, Owner, and A/E and must be approved by all parties prior to implementation. The naming/numbering/tagging convention must be consistent

and reflected through the building automation control system, charts, diagrams, tagging and O&M manuals.

B. Designate all equipment, valves, and dampers by distinguishing numbers and letters on charts and/or diagrams.
   1. Tag and locate following equipment items:
      a. Valves.
      b. Dampers.
      c. Pumps.
      d. Fans.
      e. Dedicated Outdoor Air Units.
      f. Heat Pumps.
      g. Expansion Tanks.
      h. Air Separators.
      i. Unit Heaters.
      j. Cabinet Unit Heaters.
      k. Electric Baseboard Heaters.

C. Install tags on all devices with numbers and letters corresponding to charts.

D. Fasten tags securely to devices with tag fasteners in manner for easy reading.

E. Attach equipment nameplates in conspicuous location on item of equipment or apparatus such as starters, pumps, fans, HVAC units and control panels.
   1. Secure nameplates with self-tapping screws, or nuts and bolts.

F. For unsuitable conditions, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

G. Furnish 4 charts including device number, location (room number, department) and purpose.
   1. Mount 1 chart in frame and secure on wall in location directed by Owner.
   2. Include remaining 3 sets in "Operation and Maintenance Manuals."

H. Provide all devices located above ceilings with additional identification.
   1. Use access panel markers (metal-tack-style) for acoustical tile ceilings, or engraved plastic style, 3/4 inch square, for mounting on panel door.
   2. Coordinate with the Owner on identification method and color codes.

3.2 PIPE IDENTIFICATION

A. Locate pipe markers as follows:
   1. Next to each valve and fitting, except on plumbing fixtures and equipment.
   2. At each branch or riser take-off.
   3. At each passage through walls, floors, and ceilings.
   4. At each pipe passage to underground.
   5. On all horizontal pipe runs every 20 feet, at least once in each room and each story traversed by piping system.
   6. Identify piping contents, flow direction, supply and return.

B. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.3 SERVICE ABBREVIATIONS

A. General

1.	D	Drain
2.	GS	Geothermal Supply
3.	GR	Geothermal Return

3.4 CONTROL SEQUENCE OF OPERATION AND DIAGRAMS

A. Provide HVAC control and systems sequence of operations and diagrams in wall mounted frames.
   1. Mount framed diagrams in conspicuous, easily accessible places in equipment rooms housing appropriate HVAC system.

B. Diagrams and instructions may be reduced in size, provided they are easily readable.

END OF SECTION 23 0553

SECTION 230548 - VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 23 Section "Hangars, Sleeves, and Supports" for additional requirements

1.2 DESCRIPTION OF WORK

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the Drawings and as specified herein to provide complete vibration isolation systems in proper working order.

B. Description of Systems
1. Vibration isolators and hangers.
2. Bases and rails.
3. Isolation pads.
4. Resilient penetration sleeve/seal and lateral guides.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM, and AASHO standards.

B. A Practical Guide to Noise and Vibration Control for HVAC Systems, by M.E. Schaffer, and published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 30329.

1.4 SUBMITTALS

A. Shop Drawings
1. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
2. Special details necessary to convey complete understanding of the work to be performed.

B. Product Data
1. A complete description of products to be supplied, including product data, dimension, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:
   a. The equipment identification mark.
   b. The isolator type.
   c. The actual load.
   d. The static deflection expected under the actual load.
   e. Specified minimum static deflection.
   f. The additional deflection to solid under actual load.
   g. The ratio of spring height under actual load to spring diameter.

3. Spring Isolators
   a. Spring diameter.
   b. Deflection.
   c. Compressed spring height.
   d. Solid spring height.
   e. Point location of each isolator.
   f. Load at each point.
   g. Field static deflection.
   h. Horizontal loading and bolt requirements.
   i. Indicate all bases and rail clearances.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
   1. Operating and maintenance data.
   2. Guarantees.

1.5 SPEED AND BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

A. Fans and other rotating mechanical equipment shall not operate at speeds in excess of 80% of their true critical speed.

B. Vertical vibration of rotating equipment shall not be greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	**Vibration Displacement (MILS Peak-to-Peak)**
Under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
Over 2000 rpm	1

C. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sound, Vibration and Seismic Control Devices
   1. Amber/Booth Co.
   2. Mason Industries, Inc.
   3. Kinetics Noise Control.
   4. The VMC Group.

B. Sealants for acoustical purposes as described in this section are to be one of the non-setting sealants indicated below or an approved equivalent.
   1. Acoustical sealant D.A.P.
   2. BR-96 Pecora.
   3. Acoustical sealant Tremco.
   4. Acoustical sealant U.S.G.

2.2 GENERAL

A. Provide piping and equipment isolation systems as specified and/or as indicated on Drawings.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.
   1. Provide vibration isolation equipment including mountings, hangers, structural steel bases, and welded concrete pouring forms from a single manufacturer or vibration isolation equipment supplier.

C. Coat all vibration isolation systems exposed to moisture and an outdoor environment as follows:
   1. All steel parts to be hot-dip galvanized.
   2. All bolts to be cadmium-plated.
   3. All springs to be cadmium-plated and neoprene-coated.

D. Coordinate the requirements of this Section with those of Division 23 Section "Seismic Restraint".

E. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate equipment plan dimensions with size of housekeeping pads.

F. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.

G. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the Drawings, without claim for additional payment.

H. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

2.3 VIBRATION ISOLATORS AND HANGERS

A. Equipment Mounting Isolators
   1. Type 1 Isolators: Double-deflection neoprene mountings.
      a. Minimum static deflection: 0.35 inch.
      b. Steel top plate and base plate completely embedded in color-coded neoprene stock.
      c. Friction pads both top and bottom to eliminate the need for bolting.
      d. Where bolting is required, provide bolt holes in base plate and tapped holes in top plate.
      e. Mason Industries, Type ND; or Vibration Mountings & Controls, Type RD.
   2. Type 2 Isolators: Spring-type.
      a. Free-standing and laterally stable, without any housings, snubbers, or guides.
      b. Provide 1/4-inch neoprene acoustical friction pads between baseplate and support.

c. Provide mounting with leveling bolts that must be rigidly bolted to equipment.
d. Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
e. Spring to have minimum additional travel to solid equal to 50% of rated deflection.
f. Mason Industries, Type SLF.

3. Type 3 Isolators: Spring-type with vertical limit stop.
   a. Equal to Type 2 isolator, except mountings shall incorporate a resilient vertical limit stop to prevent spring extension during weight changes.
   b. Installed and operating heights to be the same.
   c. Maintain a minimum clearance of 1/2-inch around restraining bolts and between housing and spring so as not to interfere with spring action.
   d. Limit stops to be out of contact during normal operations.
   e. Mason Industries, Type SLR.
4. Type 4 Isolators: Neoprene wafer pads.
   a. Durometer or hardness to suit application.
   b. Square waffle pattern on 1/2-inch centers.
   c. Standard pads thickness: 5/16 inch; provide optional pad thickness to suit application.
   d. Provide natural rubber, hycar, butyl, silicone or other elastomers as prior approved material.
   e. Provide type "W" adhesive, both sides, for all non-bolted applications.
   f. Mason Industries, Type "W", "WMW", "WML", or "WM".

B. Vibration Hangers
1. Type 5 Isolators: Steel spring-type hanger.
   a. Steel spring and 0.3-inch deflection neoprene element in series.
   b. Neoprene element to be molded with a rod isolation bushing that passes through the hanger box.
   c. Springs to have a minimum additional travel to solid equal to 50% of rated deflection.
   d. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.
   e. Mason Industries, Type 30N.
2. Type 6 Isolators: Precompressed steel spring-type hanger.
   a. Equal to Type 5, except spring is precompressed to rated deflection, so piping or equipment are maintained at a fixed elevation during installation.
   b. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
   c. Mason Industries, Type PC30N.
3. Type 7 Isolators: Steel spring in neoprene cup-type hanger.
   a. Steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of hanger rod.
   b. Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
   c. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.
   d. Spring to have a minimum additional travel to solid equal to 50% of rated deflections.
   e. Provide an eye bolt on spring end and provision to attach housing to flat iron duct straps.

f. Mason Industries, Type W30.

4. Type 8 Isolators: Double-deflection neoprene-type hanger.
   a. Minimum static deflection: 0.40 inch
   b. Elements to be color-coded neoprene stock for easy identification of rated load capacity.
   c. Provide hanger for direct attachment to flat iron duct straps.
   d. Mason Industries, Type WHD.

2.4 BASES AND RAILS

A. Type A: Integral structural steel base.
   1. Rectangular, except for equipment which may require "T" or "L"-shaped.
   2. Perimeter Members: Beams with a minimum depth equal to 1/10 of the longest dimension of the base.
   3. Beam depth need not exceed 14 inches, provided that deflection and misalignment are kept within acceptable limits as determined by the manufacturer.
   4. Provide height-saving brackets in all mounting locations to provide a base clearance of 1 inch.
   5. Mason Industries, Type WF.

B. Type B: Steel rail.
   1. Provide steel members welded to height-saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base.
   2. Members must be sufficiently rigid to prevent strains in the equipment.
   3. Mason Industries, Type ICS.

C. Type C: Structural steel and concrete base.
   1. Rectangular structural beam or channel concrete forms for floating foundations.
   2. Minimum Base Depth: 1/12 of longest dimension of the base, but not less than 6 inches.
   3. Base depth need not exceed 12 inches unless specially recommended by base manufacturer for mass or rigidity.
   4. Bases for Split-Case Pumps: Large enough to provide support for suction and discharge base ells.
   5. Provide minimum concrete reinforcement consisting of 1/2-inch bars or angles welded in place on 6-inch centers running both ways in a layer 1-1/2 inch above bottom, or additional steel as is required by structural conditions.
   6. Provide steel members to hold anchor-bolt sleeves when anchor bolts fall in concrete locations.
   7. Provide height-saving brackets in all mounting locations to maintain a 1-inch clearance below the base.
   8. Mason Industries, Type K (Type BMK).

D. Type D: Curb-mounted base.
   1. Factory-assembled isolation base that fits over roof curb and under the isolated equipment.
   2. Provide extruded aluminum top member to overlap bottom member to provide water run-off independent of the seal.
   3. Provide cadmium-plated springs with a 1-inch minimum deflection with 50% additional travel to solid.
   4. Spring Diameter: Not less than 0.8 of spring height at rated load.

5. Provide resilient snubbers in corners with minimum clearance of 1/4-inch for wind resistance.
6. Provide a weather seal of continuous closed-cell sponge material both above and below base and a waterproof flexible ductlike EPDM connection.
7. Foam or other contact seals are not acceptable at spring cavity closure.
8. Mason Industries, Type CMAB.

2.5 ISOLATION PADS

A. Type IP1: Field-assembled for equipment mounting.
1. Construction: 4 inch thick, 3,000 psig, concrete pad poured over a 4-inch precompressed glass fiber isolation pad.
2. Glass Fiber Pads
   a. Inorganic inert material with loading capacity up to 500 psig.
   b. Covered with an elastomeric coating to increase vibration dampening and to protect media.
3. Concrete Caps
   a. 9 sq. ft. in area or less: Reinforced with 6 x 6 x 6 x 6 mesh.
   b. Larger than 9 sq. ft. in area: Reinforced with No. 4 rebar 12-inch o.c. each way.
4. Provide concrete caps with beveled edges.

B. Type IP2: Field-assembled for equipment isolation bases.
1. Isolation Bases: Field-assembled concrete pads provided by General Contractor. See Division 03 and structural drawings.
2. Provide isolation bases with an isolation joint to isolate pad from floor slab. See Division 03.
3. Make isolation bases 1 foot larger each way than equipment mounting base or skid, and size in accordance with approved equipment shop drawings.
4. Make isolation bases minimum 1'-2" thick with top of pad 4 inches above finished floor slab.
5. Reinforce isolation bases as indicated in specifications and drawings.
6. Type IP2 isolation pads provided by General Contractor and coordinated by mechanical work.

2.6 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals are to be field-fabricated from a pipe or sheet metal section that is 1inch larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated.

B. Sleeve to extend 1 inch beyond the penetrated construction on each side. The annular space between the sleeve and the penetrating element to be packed tightly with fire-stop-rated glass fiber or mineral wool to within 1/4 inch of the ends of the sleeve.

C. The remaining 1/4-inch space on each side is to be filled with acoustical sealant to form an airtight seal. The penetrating element is to be able to pass through the sleeve without contacting the sleeve.

D. Alternatively, prefabricated fire-rated sleeves accomplishing the same result are acceptable.

2.7 RESILIENT LATERAL GUIDES

A. These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.

B. Resilient lateral guides shall be one of the following products:
   1. Mason Industries, Type ADA.
   2. Peabody Noise Control, Type RGN.
   3. Vibration Mounting & Controls, Type MDPA.
   4. Approved equal guides (custom made) by Amber/Booth or Korfund Dynamics.

2.8 FLEXIBLE PIPE CONNECTORS

A. Spherical Rubber Connector
   1. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners, and Kevlar tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.
   2. Sizes 2-inches and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16 inches to 24 inches may be single sphere.
   3. Sizes 3/4 inch to 1-1/2 inch may have threaded two-piece bolted flange assemblies, one sphere and cable retention.
   4. Connectors shall be rated at 250 psi up to 170 deg F with a uniform drop in allowable pressure to 215 psi at 250 deg F in sizes through 14 inches. 16 inches through 24 inches single sphere minimum ratings are 180 psi at 170 deg F and 150 psi at 250 deg F. Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1.
   5. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
   6. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods.
   7. If control rods are used, they must have 1/2-inch-thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi maximum on the washer area.
   8. Submit two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.
   9. All expansion joints shall be installed on the equipment side of the shut-off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU and Controls Rods CR as manufactured by Mason Industries, Inc. or approved equal.

B. Flexible Pipe Hoses: Type FPH, stainless-steel-type.
   1. Stainless steel braid and carbon steel fittings.
   2. Sizes 3-Inch and Larger: Flanged.
   3. Sizes 2-1/2-Inch and Less: Male nipples.
   4. Mason Industries, Type BSS; or Vibration Mountings, Type MFP.

2.9 FLEXIBLE DUCT CONNECTIONS

A. Flexible duct connections shall be UL/FM-approved, fabricated from coated fabric (or loaded vinyl as called for on the drawings). The clear space between connected parts shall be a minimum of 3 inch and the connection shall have 1.5 inch minimum of slack material. Connections shall be suitable for not less than 10-inch w.c. operating static pressure.

PART 3 - EXECUTION

3.1 APPLICATION

A. General
1. Install all vibration control equipment in accordance with manufacturer's installation instructions and as specified.
2. All vibration control equipment shall be selected as specified and sized in accordance with weight distribution, pull or torque imposed by shop-drawing-approved equipment being isolated.
a. Minimum static deflections may be revised subject to prior approval.
b. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.
1) Provide revised vibration control equipment to match revised or substituted equipment.
3. Locations of all vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.
a. All vibration isolators to be aligned squarely above or below mounting points of the supported equipment.
b. Isolators for equipment with bases to be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
c. Locate isolators to provide stable support for equipment, without excess rocking. Consideration to be given to the location of the center of gravity of the system and the location and spacing of the isolators.
d. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
e. Hanger rods for vibration isolated support to be connected to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.
f. Vibration isolation hanger elements to be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
g. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Isolator deflections must be the largest determined by the provisions for pipe isolation. Do not mix isolated and non-isolated pipes on the same trapeze.
h. No pipes or equipment are to be supported from other pipes or equipment.
i. Resiliently isolated pipes are not to contact the building construction or other equipment.
j. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

B. Major Equipment

1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on 4-inch-high concrete housekeeping pads. See architectural or structural Drawings for details.
2. Flexible duct connections are to be installed at all fan unit intakes, fan unit discharges, and wherever else shown on the Drawing.
3. Flexible pipe connections are to be installed at all pipe connections to vibration isolated equipment in the positions shown on the Drawings.

C. Resilient Pipe Hangers and Supports
1. Isolation hangers shall be used for all piping in equipment rooms and up to 50 feet from vibrating equipment. To avoid reducing the effectiveness of equipment isolators, at least the first three hangers from the equipment shall provide the same deflection as the equipment isolators, with a maximum limitation of 2-inch deflection; the remaining hangers shall be spring or combination spring and rubber with 0.75-inch deflection. The first two hangers adjacent to the equipment shall be the precompressed type, to prevent load transfer to the equipment flanges when the piping system is filled.
2. Floor-supported piping in equipment rooms and adjacent to isolated equipment shall use vibration isolators. The first two adjacent floor supports shall be the restrained spring type, with a blocking feature that prevents load transfer to equipment flanges as the piping is filled or drained. Where pipe is subjected to large thermal movement, a slide plate (PTFE, graphite, or steel) shall be installed on top of the isolator, and a thermal barrier shall be used when rubber producers are installed directly beneath steam or hot water lines.
3. Where lateral support of pipe risers is required within the specified limits, this is to be accomplished by use of resilient lateral guides.
4. Pipes within the specified limits (three support positions) that penetrate the building construction are to be isolated from the building structure by use of resilient penetrating sleeve/seals.
5. Drain piping connected to vibration isolated equipment shall not contact the building structure or other non-isolated system unless it is resiliently isolated.

3.2 VIBRATION ISOLATORS

A. Use Type 1 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. Utility fans, 5 hp or less.
2. Air compressors, 3 hp or less.
3. Minimum static deflections, 0.35 inch.

B. Use Type 2 isolators for equipment mounted on all floors.
1. Utility fans, 7-1/2 hp and larger.
2. All SWSI and DWDI blowers.
3. All vane axial type fans.
4. All packaged air handling units.
5. Minimum static deflections, 0.75 inch.

C. Use Type 2 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. Air compressors, 15 hp and larger.
2. All pumps, 30 hp and larger.
3. Reciprocating chillers, 25 tons and less.
4. Screw-type chillers, 50 tons and less.
5. Minimum static deflections, 1.5 inch.

D. Use Type 3 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. Reciprocating chillers, 30 tons and larger.
2. Screw-type chillers, 60 tons and larger.
3. All centrifugal chillers.
4. All absorption chillers.
5. All indoor mounted fluid coolers or condensers (closed circuit cooling towers).
6. All boilers.
7. Minimum static deflections, 1.5 inch.

E. Use Type 4 isolation pads for equipment mounted on grade supported floor slabs.
1. Air compressors.
2. Chillers.
3. Fluid coolers.
4. Boilers.
5. Utility fans, 5 hp or less.
6. Minimum static deflections, 0.3 inch.

F. Use Type 5 vibration hangers for suspended equipment.
1. Individual runs of piping, 3-inch and smaller.
2. In-line fans, 3 hp and smaller.
3. In-line pumps, 2 hp and smaller.
4. Fan coil units, 1 hp and smaller.
5. Minimum static deflections, 0.3 inch.

G. Use Type 6 vibration hangers for suspended equipment.
1. Trapeze-type pipe hangers.
2. Individual runs of piping, 4 inch through 6 inch.
3. Inline fans, 5 hp through 7-1/2 hp.
4. Inline pumps, 3 hp through 5 hp.
5. Fan coil units, 1-1/2 hp and larger.
6. Minimum static deflection, 1.5 inch.

H. Use Type 6 or Type 7 vibration hangers for suspended equipment.
1. Trapeze-type pipe hangers.
2. Individual runs or piping, 8 inch and larger.
3. In-line fans, 10 hp and larger.
4. In-line pumps, 7-1/2 hp and larger.
5. Package air handling units.
6. Minimum static deflection, 2.5 inch.

I. Use Type 8 vibration hangers for suspended equipment.
1. In-line fans 1/2 hp or smaller.
2. Fan coil units 1/2 hp or smaller.
3. Utility fans 1/2 hp or smaller.
4. Minimum static deflection, 0.40 inch.

3.3 BASES AND RAILS

A. Use Type A integral structural steel bases for equipment mounted on floors other than grade-supported floor slabs.
1. Package air handling unit fan cabinets, 15 hp and larger.

2. SWSI and DWDI blowers, 5 hp through 15 hp.
3. Utility fans, 7-1/2 hp through 10 hp.

B. Use Type B structural rails for equipment mounted on floors other than grade supported floor slabs.
1. Package air handling unit fan cabinets, 10 hp and smaller.
2. Indoor mounted fluid coolers.
3. Reciprocating chillers, 25 tons and smaller.
4. Screw-type chillers, 50 tons and smaller.

C. Use Type C concrete platforms for equipment mounted on floors other than grade supported floor slabs.
1. Air compressors, 15 hp and larger.
2. All base-mounted pumps, 30 hp and larger.

D. Use Type C concrete platforms for equipment mounted on all floors.
1. SWSI and DWDI blowers, 20 hp and larger.
2. Utility fans, 15 hp and larger.

E. Use Type D curb mounted isolation system for equipment mounted on roofs.
1. Rooftop units, 50 tons and larger.
2. Roof-mounted air handling units, 50 tons and larger.
3. Cooling towers, 100 tons and larger.
4. Condensing units, 25 tons and larger.
5. Fluid coolers, 100 tons and larger.
6. Utility fans, 7-1/2 hp and larger.

3.4 ISOLATION PADS

A. Use Type IP1 isolation pads for equipment mounted on floors other than grade-supported floor slabs.
1. Air compressors, 5 hp through 10 hp.
2. All base-mounted pumps, 25 hp and less.

B. Use Type IP2 isolation pads for equipment mounted on grade.
1. Boilers.
2. Chillers.
3. Deareators.
4. Indoor mounted fluid coolers.
5. Incinerators.
6. Pump groups where one pad serves two or more pumps.
7. Flue gas economizers supported from the floor.

3.5 FLEXIBLE PIPE CONNECTIONS

A. Use Type FPC flexible connectors in piping systems.
1. Pump Suction and Discharge
   a. Exception: When three or more mechanical grooved pipe (Victaulic type) couplings are used at each pump suction or discharge side.
2. Chiller Inlet and Outlet

a. Exception: When three or more mechanical grooved pipe (Victaulic type) couplings are used at each chiller evaporator and condenser outlet and inlet.

3. Building expansion joints.

B. Use Type FPH flexible hose in piping systems.
1. Air compressor discharge piping.
2. Vacuum pump suction piping.
3. Fuel oil pump suction and discharge piping.

C. Install flexible pipe connections and flexible hoses on equipment side of equipment isolation valves.

D. Provide flexible connectors and flexible hose to suit the application.
1. Indicate specific applications on shop drawings.

3.6 FLEXIBLE DUCT CONNECTIONS

A. Sheet metal ducts or plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section prior to installation of the flexible connection, so that the clear length is approximately equal all the way around the perimeter. Flexible duct connections shall not be installed until this provision is met. The fan unit or adjacent duct section shall be able to move 1 inch in any direction without causing metal-to-metal contact or stretching taut the flexible connection.

3.7 HORIZONTAL PIPE ISOLATION

A. First three pipe hangers in the main lines near mechanical equipment shall be vibration isolation hanger.

B. First three floor-mounted pipe supports shall rest on Type 3 isolators.

C. If piping is connected to equipment located in basements and hangs from structure under occupied spaces, the first three hangers shall have 0.75-inch deflection for pipe sizes up to and including 3 inch; 1.5-inch deflection for pipe sizes up to and including 6 inch; and 2.5-inch deflection thereafter.

D. Locate hanger as close to overhead supports as is practical.

END OF SECTION 23 0548

SECTION 230593 - MECHANICAL SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work Includes
   1. Furnishing all labor, materials, tools, equipment, and services to test, balance and adjust all mechanical systems as indicated, in accord with provisions of Contract Documents.
   2. Complete coordination with work of all other trades.

B. Test, balance, and adjust following mechanical systems:
   1. Air distribution systems.
   2. Air moving equipment.
   3. Circulating water systems, Geothermal Water.
   4. Instrumentation and control system.
   5. Direct Expansion (D/X) Refrigeration system
   6. Heating systems
   7. Cooling Systems

1.3 QUALITY ASSURANCE

A. Agency Qualifications: Independent balance and testing agency, member of the Associated Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

B. Balancing Standards: AABC requirements and recommendations.

1.4 RESPONSIBILITIES OF TESTING AND BALANCING AGENCY WORK

A. Schedule work with trades involved.

B. Check, adjust, and balance system components to obtain optimum conditions for function and operation of system.

C. Evaluate operation of systems and advise installer of necessary adjustments and corrective measures.

D. Prepare and submit test reports.

1.5 RESPONSIBILITIES OF HEATING CONTRACTOR'S WORK

A. Startup systems and keep in correct operation during balancing operations.

B. Make personnel accessible to provide necessary adjustments and corrections to systems as directed by balancing agency.

C. Maintain accessibility to test locations and devices requiring adjustment.

D. Add dampers required for correct air balance as recommended by the Air Balance Agency.

E. Provide additional sets of pulleys and belts as recommended by the Air Balance Agency.

F. Provide to the Test and Balance Agency a complete set of approved Shop Drawings and submittals and a posted set of Mechanical Drawings, indicating any and all changes to the Contract Documents.

1.6 JOB CONDITIONS

A. Balance at time directed by Construction Manager (CM)/ Owner
   1. If balancing is not preformed during peak cooling season, demonstrate satisfactory balancing during next peak cooling season.
   2. If balancing is not preformed during peak heating season, demonstrate satisfactory balancing during next peak heating season.

1.7 GUARANTEE

A. Provide extended warranty of 90 days, after completion of test and balance work, during which time the CM/Owner may, at their discretion, request recheck or resetting of any equipment or system which is not performing satisfactorily. Provide technicians to assist as required in making such tests.

1.8 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Not required for review.

C. Samples: Not required for review.

D. Reference Submittals: Qualifications of balancing agency and sample report forms.

E. Contract Closeout Information
   1. Balancing Reports
      a. Use forms similar to AABC latest edition.
      b. Report to include the following:
         1) All specified data.
         2) All equipment nameplate information.
         3) All traverse readings.
         4) Line sketch/diagram indicating location of traverses.
         5) Static pressure profiles.
         6) AABC equipment data sheets.
         7) Fan and pump curves.
         8) Temperature readings (all air and water streams)

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Accurately calibrate and maintain all test instruments in good working order.
   1. If requested, conduct tests of instruments in presence of CM/Owner.

B. If requested, conduct balancing tests in presence of CM/Owner.

C. Do not begin balancing until system(s) have been completed and are in good working order.

D. Record all inspections, tests, and adjustments.

3.2 AIR BALANCING METHODS

A. Balance each air system that is serviced by air filters, using artificial static loading of system, to demonstrate, test and obtain system design pressure drop data.
   1. Provide dirty filter pressure drop conditions on system.
   2. Do not use high efficiency filters (75% and above) in testing and balancing.
   3. Static pressure losses may be simulated by using wood or sheet steel blanking plates in high efficiency filter racks and housings.
   4. Do not install blanking plates within 2 feet of any low efficiency filter unit or rack.

3.3 AIR BALANCE TESTING PROCEDURE

A. Perform tests and balance system in accord with the following.

B. Test and adjust equipment capacity to design requirements and record RPM.

C. Test motor load amperes and fan rotations.

D. Make pitot tube traverse of main supply ducts and obtain design CFM at fans. Provide fan curves and plots.

E. Test system static pressure, suction and discharge.

F. Test and adjust system for design CFM outside and return air:
   1. Maximum outside air setting.
   2. Minimum outside air setting.

G. Test and adjust system for design CFM outside air.

H. Test coil entering air temperatures:
   1. Dry bulb deg F heating and cooling.
   2. Wet bulb deg F cooling.

I. Test Leaving Air Temperatures
   1. Dry bulb deg F heating and cooling.
   2. Wet bulb deg F cooling.

J. Adjust all main supply and return air ducts to proper design CFM.

K. Adjust all zones to proper design CFM, supply and return.

L. Test and adjust each diffuser, grille, and register to within 10% of design requirements.
   1. Identify location and area of each grille, diffuser, and register.
   2. Identify and list size, type and manufacturer of diffusers, grilles, and registers.
   3. Use manufacturer's ratings on all equipment to make required calculations.
   4. Readings and tests of diffusers, grilles, and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustments.
   5. Adjust all diffusers, grilles, and registers to minimize drafts.

M. In cooperation with control manufacturer's representative, set automatically operated dampers to operate as indicated.
   1. Check all controls for proper calibration and list all controls requiring adjustment by control installers.

N. Balance supply, return, and exhaust air to provide the designed pressure relationships to adjacent areas.

O. Make any changes in pulleys, belts, and dampers, to achieve capacity.

P. Check fire dampers and smoke dampers for correct operation and damper position.

Q. Adjust special equipment fans to CFM requirements as indicated.

R. List all mechanical nameplate and specifications of fans.

3.4 WATER BALANCE PROCEDURE - PHASE ONE

A. Complete air balancing before commencing water balancing.

B. Open all valves to full open position. Close coil bypass stop valves. Set mixing valve to full coil flow.

C. Check operation of all relief valves.

D. Examine water in system and determine if water has been treated and cleaned.

E. Checks pump rotation.

F. Check expansion tanks to determine they are not air-bound.

G. Check for installation and proper operation of air valves.

H. Set temperature controls for all coils at maximum flow. Check for full closure of all automatic bypass valves.

I. Check operation of automatic bypass valves.

3.5 WATER BALANCE PROCEDURE - PHASE TWO

A. Ensure start-up strainers have been removed.

B. Set pumps to specified gallons per minute delivery.

C. Adjust water flow of geothermal water to supply main.

D. Balance each geothermal water coil.

3.6 WATER BALANCE PROCEDURES - PHASE THREE

A. After completing coil balancing, test geothermal water pressures and flows at the pumps and re-adjust if required.

B. Adjust Coil Bypass Valves: Install pressure gages on coil, read pressure drop through coil at maximum flow rate.
1. Set pressure drop across bypass valve to match coil maximum flow pressure drop.
2. Adjust flow rate through each coil in coil banks.

C. Check following at each cooling and heating unit.
1. Inlet water temperatures.
2. Leaving water temperatures.
3. Pressure drop of each coil.
4. Pressure drop across bypass valve.
5. Pump operating suction and discharge pressures and final total dynamic head.
6. Water metering device readings.

D. List all mechanical specifications of pumps.

E. Record nameplate and actual operating amperages of pump motor.

3.7 OPERATING TEST

A. After systems are balanced, conduct operating test of not less than 8 hours' duration to demonstrate to satisfaction of the CM/Owner that systems comply with requirements of plans and specifications, and that all equipment and controls are functioning properly.

END OF SECTION 23 0593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. Section Includes
1. Duct Insulation.
2. Pipe Insulation.
3. Equipment Insulation.
4. Insulation Adhesive.
5. Insulation Sealant.
6. Insulation Mastic.
7. Insulation Jacketing.

1.3 QUALITY ASSURANCE

A. All testing and ratings shall meet the standards set in ASTM E-84, NFPA 255, and UL 723.

B. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50. Outdoor insulation shall have a flame-spread rating not exceeding 75 and a smoke developed rating not exceeding 150.

C. Insulation accessories shall have the same or better ratings as the insulation product they serve.

D. Insulation values shall be in accordance with the State Energy Codes.

E. Maximum insulation temperature limits must exceed maximum fluid working temperatures.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with flame and smoke ratings, and maximum use temperature.

B. Protection: Leave insulation boxed and stored until time for use. Elevate and cover material to avoid moisture, dust, and physical abuse.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields with ductwork and piping installer.

B. Coordinate clearance requirements with piping installer for piping insulation application and ductwork installer for duct insulation application, and equipment installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and

maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fiberglass Insulation: Owens-Corning, Knauf, CertainTeed, Johns Manville, and Manson.

B. Closed-cell Insulation: Aeroflex, Armacell, and K-flex.

C. Calcium Silicate Insulation: Owens-Corning, Johns Manville, or Industrial Insulation Group (IIG).

D. Adhesive: Foster, Johns Manville, and 3M.

E. Sealant: Foster, Boss Products, and Dow Chemical.

F. Mastic: Foster.

G. Aluminum Jacketing: Ideal Products, Pabco, and RPR Inc.

H. PVC Jacketing: Proto, and Johns Manville.

2.2 GENERAL

A. Products shall not contain asbestos, lead, mercury, or mercury compounds and be HCFC free.

B. Use of water-soluble treatments is prohibited.

2.3 TYPES OF INSULATION

A. Type 1: Fiberglass heavy-density insulation with all service jacket and pressure sealing lap adhesive on longitudinal and butt strips. Jacket vapor membrane shall have an installed vapor permeance of not more than 0.09 perms. Staple and seal with pressure-sealing lap adhesive on longitudinal and butt strips. Thermal conductivity (k-value) not greater than 0.23 at mean temperature of 75 deg F.

B. Type 2: Flexible closed cell elastomeric thermal pipe insulation. Thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50.

C. Type 3: Flexible fiberglass duct wrap laminated to foil-reinforced kraft vapor membrane facing with 2 inch stapling flange. 1.0 pcf density with thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

D. Type 4: Semirigid fiberglass industrial board with foil scrim kraft vapor membrane facing. 3.0 pcf density with thermal conductivity (k-value) not greater than 0.23 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

E. Type 5: Rigid fiberglass industrial board with foil scrim kraft vapor membrane facing. 6.0 pcf density with thermal conductivity (k-value) not greater than 0.22 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

F. Type 6: Flexible closed cell elastomeric thermal sheet insulation. Thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50.

G. Type 7: Rigid hydrous calcium silicate insulation ASTM C533, C795 Type 1. Thermal conductivity (k-value) not greater than 0.42 at 200 deg F. Mitered or scored to fit designed circumference. Rated for 1200 deg F. Install in staggered joint position over high-rib metal lath. Field-applied 0.016-inch-thick aluminum jacketing secured with sheet metal screws over wire or stainless steel banding.

H. TYPES OF JACKETING

I. Type 1: PVC jacket. 0.030-inch-thick ultraviolet-resistant PVC jacket. Jacket is to be self-extinguishing and have zero fuel contribution.

J. Type 2: Aluminum jacket. 0.016-inch-thick aluminum jacket with "Pittsburgh Seam." Seal between metal jacket and sleeve.

K. Type 3: Rubberized bitumen membrane. 0.060 inch thick. Designed with a cross laminated high strength polyethylene laminated to raw aluminum. This film is then laminated to rubberized bitumen compound with a release liner. Self-healing if punctured, UV stable, and will expand and contract with the mechanical system. "Alumaguard" / "Alumaguard Lite" as manufactured by Polyguard. Install a layer of "Alumaguard" on the top & sides of duct and "Alumaguard Lite" on the bottom. For cold weather installations the "Alumaguard LT" as manufactured by Polyguard, can be used. Install per manufacturer's instructions.

2.4 FITTINGS AND VALVES

A. Premolded PVC covers over molded insulation. Insulation same thickness as on adjoining pipe. Insulation shall have a flame-spread rating not exceeding 25 and a smoke-developed rating not exceeding 50.

2.5 SCHEDULE OF INSULATION

System Type	Fluid Temperature Range (F)	Insulation Type	Insulation Thickness					
			1" and smaller	1" to 1-1/4"	1-1/2" to 3"	4" to 6"	8" and larger	Duct or Equip.
Hydronic Piping								
Geothermal Water (*D)	40 – 100	1	1.0	1.0	1.0	1.0	1.0	N/A
Cooling Coil Condensate	40 – 60	1 or 2	0.5	0.5	1.0	1.0	1.0	N/A
Make-up Water	40 – 60	1 or 2	0.5	0.5	1.0	1.0	1.0	N/A
Duct								
Supply	45 – 120	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.5
(*A) Return	70 – 95	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.0
Outside Air	-20 – 120	3 (*C)	N/A	N/A	N/A	N/A	N/A	2.0
(*B) Relief Air	70 – 95	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.0
(*B) Exhaust	70 – 95	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.0
Equipment								
Geothermal Water Tanks	100 – 200	4 or 5	N/A	N/A	N/A	N/A	N/A	1.5
Geothermal Water Air Separators	100 – 200	4 or 5	N/A	N/A	N/A	N/A	N/A	1.5
Geothermal Water Pumps	40 – 60	4, 5, or 6	N/A	N/A	N/A	N/A	N/A	1.0
Note: For piping and ductwork exposed to outdoor temperatures, increase thickness by 0.5 inches.								
*A: Only ductwork/Piping in non-air-conditioned areas (Including: Shafts, Ceiling space with roof above, and Attics) or ductwork/Piping exposed to outdoor temperatures.								
*B: Only ductwork/Piping exposed to outdoor temperatures or ductwork from plenum at louver (or other outside opening) back to motorized or backdraft damper.								
*C: For visible rectangular ductwork (non-mechanical rooms) or ductwork installed outside use Type 4 or Type 5 insulation. For mechanical rooms use Type 4 or Type 5 insulation for rectangular ductwork with bottom of duct elevation below 10 feet A.F.F.								
*D: All metallic piping and where required on HDPE piping (Not required for HDPE piping above layin ceiling; or exposed piping in mechanical rooms (with floor drain and concrete floor). Any piping above or over a non-accessible ceiling (drywall) or concealed (chases, etc) shall be insulated. Any piping within 25 feet of exit doors shall be insulated.								

2.6 EXPOSED INDOOR PIPING LESS THAN 10 FEET ABOVE NEAREST WALKING SURFACE

A. Cover piping insulation with Type 1 or Type 2 Jacketing.

2.7 OUTDOOR PIPING

A. Cover piping insulation with Type 2 Jacketing.

2.8 OUTDOOR DUCTWORK

A. Cover ductwork insulation with Type 3 Jacketing. For the top of rectangular ductwork, under the jacketing provide tapered insulation centered on the duct to slope to the sides for drainage. Tapered insulation shall run the entire length of duct.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Verify that systems and equipment to be insulated have been tested and are free of defects.

C. Verify that surfaces to be insulated are clean and dry.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in schedule of insulation.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Apply insulation with duct and pipe surfaces at room temperature.

M. Make insulation continuous except through fire-rated walls/floors. Do not leave gaps in insulation at sleeves, hangers, anchors, supports, etc.

N. Insulate all fittings, valve bodies, flanges, and other pipe accessories.

O. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 3 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

P. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

R. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

S. For insulation at hangers and bracing, see Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

3.4 EQUIPMENT INSULATION INSTALLATION

A. Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
   a. Do not weld anchor pins to ASME-labeled pressure vessels.
   b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
   c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
   d. Do not overcompress insulation during installation.
   e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
   f. Impale insulation over anchor pins and attach speed washers.
   g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
   1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
   2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps
   1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from galvanized steel, at least 0.050 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 DUCT INSULATION INSTALLATION

A. Flexible fiberglass duct wrap installations: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
   c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
4. Impale insulation over anchors and attach speed washers.
5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Semi-rigid and rigid fiberglass board installations: Secure board insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Space anchor pins as follows:
   a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.

4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.6 PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable

insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 PIPING CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties
1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 PIPING FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties
1. Install preformed valve covers manufactured of same material as pipe insulation when available.

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

3.9 PIPING CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties
1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

END OF SECTION 23 0700

SECTION 230800 COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Division 22 – Plumbing

B. Division 26 - Electrical

1.2 REFERENCES

A. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions, and Division-1 Specification sections, apply to work of this section.

B. ASHRAE Guideline 1—1996

C. ASHRAE Guideline 0—2005

D. ACG Commissioning Guideline — 2005

1.3 DESCRIPTION OF WORK

A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed matter and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers, and equipment suppliers.

B. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal. Performance Test results may be used in determining the start of the warranty period for HVAC systems and subsystems.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 ROLES OF THE COMMISSIONING AUTHORITY

A. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of HVAC systems within the facility.

B. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system.

Services include documenting construction observations, verification, and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

C. Assist the responsible parties to maintain a high-quality level of installation by meeting or exceeding prevailing standards and specifications.

D. The CA shall observe, and coordinate testing as required to assure system performance meets the design intent.

E. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

F. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

G. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

H. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for HVAC systems and subsystems.

I. The CA will review operating and maintenance materials for HVAC systems.

J. The CA will review phasing plans as provided by the CM relating to temporary use of HVAC equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

3.2 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

A. Water Sourced Geothermal Heat Pumps and associated Loop system components.

B. Dedicated Outside Air Systems

C. Unit Heaters

D. Electric Baseboard Heaters

E. Destratification Fans

F. VFD's

G. DDC Control System

3.3 HVAC COMMISSIONING PLAN

A. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing

supervisory position on this project. One team member shall be provided by each of the parties listed below:

1. Program Manager (PrM)
2. Facilities Management Division (FMD)
3. Commissioning Agent (CA)
4. Design Team (DT)
5. Construction Manager (CM)
6. Mechanical Contractor (MC)
7. Controls Contractor (CC)
8. Test and Balance Contractor (TABC)
9. Electrical Contractor (EC)

B. Basis of Design Document

1. The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.

2. The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

C. Commissioning Meetings

1. Commissioning meetings will be held in conjunction with progress meetings as necessary. The CA will be on site for the CX meetings. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

D. Resolution Tracking Forms (RTF)

1. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.

2. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. System Verification Checklists (SVC) / Manufacturers' Checklists

1. The MC will provide SVC's based on manufacturers start-up procedures. These tests should be provided for all systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.

2. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.

3. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor and reviewed by the CA before start-up can commence.

F. Start-Up

1. Start-up of major HVAC systems will be witnessed the CA. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting HVAC equipment.

2. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

G. Controls Monitoring

1. Close monitoring of the Control Contractor's progress will promote efficient coordination of the TAB work. The CC will be expected to submit point-to-point checklists verifying that his work has been completed and all systems are ready for TAB work and Functional Performance Testing. Programming and graphics will be surveyed by the CA for completeness and conformance with the BoD and the owner's scheduling requirements.

H. TAB Monitoring

1. The preliminary TAB report set-up will be reviewed prior to HVAC equipment start-up, in order to assure that the final TAB report format and content is acceptable.

2. TAB work will be monitored so that any problems that prevent or hinder proper air and water balance can be addressed and corrected with minimal delays. By addressing these problems as quickly as possible, we can assure that functional performance testing and owner training will take place on schedule.

3. A pencil copy of the TAB report will be reviewed prior to submission of the final TAB report. A written review will be submitted to the TAB contractor and to the DT for their comments. A TAB report approved by the DT will be required before Functional Performance Testing can be carried out. The CA will visit the site during the TAB process in order to assist TABC and CC in the effective completion of their scope of work.

I. Functional Performance Tests (FPT)

1. The CA will write FPT's based on the respective sequence of operations. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS above.

2. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.

3. The Functional Performance Tests shall include HVAC and related equipment.

4. Heat Pumps will be tested in designed operating modes. Proper operation will be verified at automatic control, and other modes, if necessary, to achieve BOD conformance.

    a. Dedicated Outside Air System will be tested for conformance to BoD.

    b. Destratification Fan will be tested for conformance to BoD.

    c. Hydronic pumps will be tested under relevant operating conditions.

    d. Electric Heaters will be tested under relevant operating conditions.

    e. DDC control systems will be tested as necessary.

    f. HVAC systems will be tested to assure that the building as an integrated system operates properly.

    g. Trend verification of systems and subsystems shall be completed prior to start of functional performance testing. CA will provide trend format to CC and discuss trend requirements in CX meetings throughout the construction phase of project.

5. Deferred Testing

    a. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.

    b. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.

6. Rescheduled Functional Performance Test

    a. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, their time will be billed to the contractor as an additional fee.

    b. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not pass during the retest, the contractor will be billed for the commissioning personnel's return trip.

J. Building Turn-Over / Owner Orientation / User Training

1. The CA will oversee contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.

2. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.

3. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative, and witnessed by the CA. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going HVAC related problems are being addressed and corrected in a timely and efficient manner.

4. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

3.4 RESPONSIBILITIES OF TEAM MEMBERS

A. Construction Manager (CM)

1. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the HVAC commissioning process.

2. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.

3. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.

4. Coordinate inclusion of commissioning activities in the construction schedule.

5. Facilitate resolution of deficiencies identified by observation or performance testing.

6. Involve CA in selection of the air balancing contractor.

7. Assist the CA in monitoring the duct leakage testing.

B. Mechanical Contractor (MC)

1. Each contractor in this division shall include in their quote the cost of participating in the commissioning process.

2. Include requirements for submittal data (including partial load data), O&M data, and training in each purchase order or sub-contract.

3. Assure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, water treatment, temperature controls, and TAB in commissioning activities.

4. Assure participation of major equipment manufacturers in appropriate startup, training, and testing activities.

5. Attend commissioning meetings scheduled by the CA.

6. Assist the CA in system verification and performance testing.

7. Prepare preliminary schedule for HVAC system inspections, O & M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, system verification, performance testing, and system completion for use by the CA. Update schedule as appropriate throughout the construction period.

8. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of HVAC equipment.

9. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.

10. Notify the CA a minimum of two weeks in advance of scheduled system start-up.

11. Update drawings to as-built condition and review with the CA throughout the construction process.

12. Schedule vendor and subcontractor provided training sessions as required by project specifications.

13. Provide written notification that the following work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent.

14. HVAC equipment including fans, air handling units, dehumidification units, ductwork, dampers, terminal devices, etc.

15. Fire detection and smoke detection devices furnished under other divisions as they affect the operation of the HVAC systems.

16. That BAS is functioning in accordance with design intent.

17. Participate in the Functional Performance Tests.

18. Participate in the off-season mode testing.

19. Participate in O&M Training as required by project specifications.

20. Provide a complete set of as-built drawings and O & M manuals for review. The CA shall review the as-built drawings and O&M manuals concurrently with the design team.

C. Test and Balance Contractor (TABC)

1. Include cost for commissioning requirements (participation) in the contract price.

2. Attend commissioning meetings scheduled by the CA.

3. Submit the TAB procedures and preliminary TAB report to the CA for review at least two weeks prior to beginning TAB work.

4. Notify the CA a minimum of two weeks in advance of scheduled TAB work.

5. Provide partial, preliminary TAB Reports by phase, by building section, by system, or as required by the CA.

6. Assist the CA in system verification and performance testing.

7. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.

8. Participate in verification of the TAB report, which will consist of repeating any selected measurement contained in the TAB report where required by the CA for verification or diagnostic purposes.

9. Participate in the Functional Performance Tests as required to achieve design intent.

10. Provide sound and vibration where required to assist in diagnosis of areas exhibiting unacceptable levels of noise or vibration.

11. Participate in the off-season mode testing as required to achieve design intent.

12. Participate in O&M Training as required by project specifications.

D. Temperature Control Contractor (TCC)

1. Include cost for commissioning requirements in the contract price.

2. Review control sequence and component selection for conformance with design intent.

3. Attend a submittal review meeting with the CA and Engineer to ensure clear understanding of scope of work and expectations.

4. Verify that specified safeties and interlocks have been selected.

5. Verify proper selection of control valves and actuators based on design parameters.

6. Verify proper selection of control dampers and actuators based on design parameters.

7. Verify that sensor selection conforms to design intent.

8. Attend commissioning meetings scheduled by the CA.

9. Provide the following submittals to the CA

10. Hardware and software submittals.

11. Control panel construction shop drawings.

12. Narrative description of control sequences for each HVAC system and subsystem.

13. Schematics showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access.

14. A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.

15. A complete listing of all software routines employed in operating the control system. Also provide a program narrative that describes the logic flow of the software and the functions of each routine and sub-routine. The narrative should also explain individual math or logic operations that are not clear from reading the software listing.

16. Hardware operation and maintenance manuals.

17. Application software and project applications code manuals.

18. Panel and equipment insert documents.

19. Assist CA with remote monitoring capabilities. Supply any software and/or hardware needed.

20. Verify that specified interfaces provided by others are compatible with BAS hardware and software.

21. Coordinate installation and programming of BAS with construction and commissioning schedules.

22. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of HVAC equipment.

23. Provide control system technician to assist during equipment startup.

24. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.

25. Participate in the Functional Performance Tests as required by the project specifications.

26. Provide a control system technician to assist during verification and performance testing.

27. Provide system modifications to achieve system operation as defined by the design intent.

28. Provide support and coordination for TAB contractor. Provide all devices, such as portable operator terminals and all software for the TAB to use in completing TAB procedures.

29. Provide written notification that the TCC scope of work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent, and that BAS is functioning in accordance with design intent.

30. Participate in the Functional Performance Tests as required to achieve design intent.

31. Participate in the off-season mode testing as required to achieve design intent.

32. Participate in O&M Training as required by project specifications. Include training on hardware operations and programming

END OF SECTION 230800

SECTION 230900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1.1.1 SUMMARY

A. This Section includes control equipment and installation for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-furnished controls.

B. See "Sequences of Operation" for requirements that relate to this Section.

1.1.1.2 RELATED DOCUMENTS

A. Drawings and Specification Sections of the Contract, including General and Supplementary Conditions, apply to this Section.
1. Division 01 – General and Special Requirements
2. Division01 – Submittal Requirements
3. Division01 – Materials and Equipment
4. Division23 – Common Work Results for HVAC
5. Section 23 – Variable Frequency Drives
6. Division23 – Testing, Adjusting, and Balancing for HVAC
7. Division26 – General Electrical Provisions for Electrical Work
8. Division26 – Common Work Results for Electrical
9. Division26 – Low Voltage Electrical Power Conductors and Cables
10. Division26 – Hangers and Supports for Electrical Systems
11. Division26 – Raceway and Boxes for Electrical Systems
12. Division26 – Identification for Electrical Systems
13. Division 26 – Wiring Devices

1.1.1.3 ABBREVIATIONS

A. AAC: Advanced Application Controller

B. AHU: Air Handling Unit.

C. ALN: Automation Level Network

D. ASC: Application Specific Controller

E. ASHRAE: American Society of Heating Refrigerating and Air-Conditioning Engineers

F. BACnet SC: Building Automation Control Network Secure Connect

G. BAS: Building Automation System

H. BC: Building Controller

I. BIBB: BACnet Interoperability Building Blocks

J. BIM: Building Information Modeling

K. BMS: Building Management System.

L. CFM: Cubic Feet per Minute.

M. DCIM: Data Center Infrastructure Management

N. DCV: Demand Controlled Ventilation

O. DDC: Direct digital controls

P. EIA: Electronics Industries Alliance

Q. EMI: Electro-Magnetic Interference

R. EP: Electric-to-Pneumatic

S. EPMS: Electrical Power Monitoring System

T. FAS: Fire Alarm System.

U. FLN: Floor Level Network

V. FCU: Fan Coil Unit

W. HMI: Human Machine Interface

X. HVAC: Heating, Ventilating and Air Conditioning.

Y. IEEE: Institute of Electrical and Electronic Engineers

Z. I/O: Input/Output

AA. IP: Internet Protocol

BB. IT: Information Technology

CC. LAN: Local area network.

DD. LCD: Liquid Crystal Display

EE. LED: Light Emitting Diode

FF. MER: Mechanical Equipment Room.

GG. MLN: Management Level Network

HH. MS/TP: Master-slave/token-passing.

II. NEMA: National Electric Manufacturers' Association

JJ. NFPA: National Fire Protection Association

KK. OEM: Operator Equipment Manufacturer

LL. PC: Personal Computer

MM. PICS: Protocol Implementation Conformance Statement

NN. PID: Proportional Integral Derivative.

OO. POT: Portable Operators Terminal.

PP. RAM: Random Access Memory

QQ. RFI: Radio Frequency Interference

RR. RTD: Resistance Temperature Device

SS. SNMP: Simple Network Management Protocol

TT. TAB: Testing and Balancing

UU. TCP: Transfer Control Protocol

VV. UDP: User Datagram Protocol

WW. UL: Underwriters Laboratories

XX. UPS: Uninterruptable Power Supply

YY. VAV: Variable Air Volume

ZZ. VFD: Variable Frequency Drive.

AAA. WAN: Wide Area Network.

1.1.1.4 DEFINITIONS

A. BACnet: An industry standard data communication protocol for Building Automation and Control Networks. Refer to the latest version of AHSRAE standard 135.

B. Scope Terminology
1. Provide = Furnish equipment, engineer, program and install
2. Furnish = Furnish equipment, engineer and program
3. Mount = securely fasten or pipe
4. Install = mount and wire

5. Wire = wire only

1.1.1.5 WORK INCLUDED

A. The BAS Contractor shall provide a complete and operational system that will perform the sequences of operation as described herein.

B. Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all system controllers, logic controllers, and all input/output devices. Items of work included are as follows:
1. Provide a submittal that meets the requirements below for approval.
2. Coordinate installation schedule with the mechanical contractor and general contractor.
3. Provide installation of all panels and devices unless otherwise stated.
4. Provide power for panels and control devices unless otherwise stated.
5. Provide all low voltage control wiring for the DDC system.
6. Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.
7. Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
8. Participate in commissioning for all equipment that is integrated into the BAS (Refer to Commissioning sections of the equipment or systems in other parts of this specification.)
9. Provide testing, demonstration and training as specified below.

C. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer.

1.1.1.6 SUBMITTALS

A. Provide submittals for fast track items that need to be approved and released to meet the schedule of the project. Provide submittals for the following items separately upon request:
1. Valve schedule and product data
2. Damper schedule and product data
3. Mounting and wiring diagrams for factory-installed control components
4. Thermostat locations

B. Provide a complete submittal with all controls system information for approval before construction starts. Include the following:
1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
2. Wiring Diagrams: Power, signal, and control wiring. Detail the wiring of the control devices and the panels. Show point-to-point wiring from field devices to the control panel. Show point-to-point wiring of hardwired interlocks. Show a ladder diagram or schematic of wiring internal to the panels, including numbered terminals. Clearly designate wiring that is done at a factory, at a panel shop or in the field.

3. Details of control panel faces, including sizes, controls, instruments, and labeling.
4. Schedule of dampers and actuators including size, leakage, and flow characteristics. If dampers are furnished by other, submit a damper actuator schedule coordinating actuator sizes with the damper schedule.
5. Schedule of valves including leakage and flow characteristics.
6. Written description of the Sequence of Operations.
7. Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels. Label control panels with network addresses and BACnet device instance numbers. Show all routers, switches, hubs and repeaters.
8. Point list for each system controller including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point, and location of I/O device.
9. Starter and variable frequency drive wiring details of all automatically controlled motors.
10. Reduced size floor plan drawings showing locations of control panels, thermostats and any devices mounted in occupied space.
11. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated. Submit a write-up of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.
12. Submit BACnet Protocol Implementation Conformance Statements (PICS) for all direct digital controllers, software and other system components that will communicate on the BAS utilizing BACnet.

C. Submit a description of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.

D. Submit blank field check-out and commissioning test reports, customized for each panel or system, which will be filled out by the technician during start-up.

E. Variance letter: Submit a letter detailing each item in the submission that varies from the contract specification or sequence of operation in any way.

F. After the BAS system is approved for construction, submit sample operator workstation graphics for typical systems for approval. Print and submit the graphics that the operator will use to view the systems, change setpoints, modify parameters and issue manual commands. Programming shall not commence until typical graphics are approved.

G. Operation and Maintenance Data: In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
1. Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.
2. Keyboard illustrations and step-by-step procedures indexed for each operator function.

3. Inspection period, cleaning methods, cleaning materials recommended and calibration tolerances.
4. Calibration records and list of set points.

1.1.1.7 PROJECT RECORD DOCUMENTS

A. Project Record Documents: Submit three (3) copies of record (as-built) documents upon completion of installation. Submittal shall consist of:
1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11 x 17 inch prints.
2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.
3. Operation and Maintenance (O & M) Manual.
   a. As-built versions of the submittal product data.
   b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
   c. Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
   d. Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
   e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
   f. Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.
   g. Graphic files, programs, and database on electronic media.
   h. List of recommended spare parts with part numbers and suppliers.
   i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
   j. Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
   k. Licenses, guarantees, and warranty documents for equipment and systems.

B. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:
1. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.
2. Description of manual override operation of all control points in system.
3. BMS system manufacturers complete operating manuals.

C. Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:
1. Complete as-built installation drawings for each building system.
2. Overall system electrical power supply schematic indicating source of electrical power for each system component. Indicate all battery backup provisions.
3. Photographs and/or drawings showing installation details and locations of equipment.
4. Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.
5. Parts list with manufacturer's catalog numbers and ordering information.
6. Lists of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.
7. Manufacturer's operation, set-up, maintenance and catalog literature for each piece of equipment.
8. Maintenance and repair instructions.
9. Recommended spare parts.

D. Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:
1. Complete programming manuals, and reference guides.
2. Details of any custom software packages and compilers supplied with system.
3. Information and access required for independent programming of system.

1.1.1.8 QUALITY ASSURANCE

A. Codes
1. Perform all wiring in accordance with Division 26, NEC, local codes and Owner's requirements.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
4. Comply with ASHRAE 135-2010 BACnet: A Data Communication Protocol for Building Automation and Control Networks.
5. Comply with ASHRAE 90.1-2010 Energy Standard for Buildings Except Low-Rise Residential Buildings.
6. All equipment shall be UL listed and approved and shall meet with all applicable NFPA standards, including UL 916 - PAZX Energy Management Systems,
   a. Provide written approvals and certifications after installation has been completed.
7. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
8. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are

delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

B. Qualifications
1. Installing contractor shall be in the business of installing and servicing DDC controls for mechanical systems, temperature and ventilation control, environmental control, lighting control, access and security, life safety and energy management as their primary business.
2. Installer Qualifications: An experienced installer who is the authorized representative of the automatic control system manufacturer for both installation and maintenance of controls required for this Project.
3. Engineering, drafting, programming, and graphics generation shall be performed by qualified engineers and technicians directly employed by the Building Automation System Contractor.
4. Supervision, checkout and commissioning of the system shall be by the local branch engineers and technicians directly employed by the Building Automation System Contractor. They shall perform commissioning and complete testing of the BAS system.

C. The BAS contractor shall maintain a service organization consisting of factory trained service personnel and provide a list of ten (10) projects, similar in size and scope to this project, completed within the last five years.

D. Final determination of compliance with these specifications shall rest solely with the Engineers and Owner who will require proof of prior satisfactory performance.

E. For any BAS system and equipment submitted for approval, the BAS contractor shall state what, if any, specific points of system operation differ from these specifications.

F. All portions of the system must be designed, furnished, installed, commissioned and serviced by manufacturer approved, factory trained employees.

G. The system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability for any existing control system component including but not limited to building controllers, advanced application controllers, application specific, personal operator workstations and portable operator's terminals, to be connected and directly communicate with any new BAS system equipment without bridges, routers or protocol converters.

1.1.1.9 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

B. Deliver, store, protect, and handle products to site under provisions of the contract Documents. Coordinate all site delivers with Construction project Manager.

C. Protect products from construction operations, dust, and debris, by storing materials inside, protected from weather in a conditioned space.

1.1.1.10 COORDINATION

A. Coordinate IP drops, network connections, user interfaces, firewall, etc with Owner's IT representative.

B. Coordinate location of thermostats, humidistats, panels, and other exposed control components with plans and room details before installation.

C. Coordinate equipment with Division 28 "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate power for control units and operator workstation with electrical contractor.

E. Coordinate equipment with provider of starters and drives to achieve compatibility with motor starter control coils and VFD control wiring.

F. Coordinate scheduling with the mechanical contractor and general contractor. Submit a schedule for approval based upon the installation schedule of the mechanical equipment.

G. Coordinate installation of taps, valves, airflow stations, etc. with the mechanical contractor.

H. Products Furnished but Not Installed Under This Section
1. Hydronic Piping accessories:
    a. Control Valves
    b. Temperature Sensor Wells and Sockets
    c. Pressure Sensor Wells and Sockets
    d. Flow Switches
    e. Flow Meters
    f. Differential Pressure Transmitters
2. Sheet metal accessories
    a. Dampers
    b. Airflow Stations
    c. Terminal Unit Controls

1.1.1.11 WARRANTY

A. Provide warranty per Division 20 Section "General Mechanical Requirements" and as supplemented in this section.

B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of 12 months from completion of system demonstration.

C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The

maximum acceptable response time to provide this service at the site shall be 24 hours.

D. During normal building occupied hours, failure of items that are critical for system operation shall be provided within 4 hours of notification from the Owner's Representative.

E. This warranty shall apply equally to both hardware and software.

PART 2 - PRODUCTS

2.1.1.1 SYSTEM DESCRIPTION

A. The Building Automation System (BAS) contractor shall furnish and install a networked system of HVAC controls. The contractor shall incorporate direct digital control (DDC) for central plant equipment, building ventilation equipment, supplemental heating and cooling equipment, and terminal units.

B. Provide networking to new DDC equipment using industry accepted communication standards. System shall utilize BACnet communication according to ANSI/ASHRAE standard 135-2010 for interoperability with smart equipment, for the main IP communication trunk to the BAS Server and for peer-to-peer communication between DDC panels and devices. The system shall not be limited to only standard protocols, but shall also be able to integrate to a wide variety of third-party devices and applications via drivers and gateways.

C. Provide standalone controls where called for on the drawings or sequences.

2.1.1.2 BUILDING AUTOMATION SYSTEM NETWORK

A. All networked control products provided for this project shall be comprised of an industry standard open protocol internetwork. Communication involving control components (i.e. all types of controllers and operator interfaces) shall conform to ASHRAE 135-2010 BACnet standard. Networks and protocols proprietary to one company or distributed by one company are prohibited.

B. Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.
1. Software applications, features, and functionality, including administrative configurations, shall not be separated into several network control engines working together.

C. BAS Server shall be capable of simultaneous direct connection and communication with BACnet/SC, BACnet/IP, OPC and TCP/IP corporate level networks without the use of interposing devices.

D. Any break in Ethernet communication from the server to the controllers on the Primary Network shall result in a notification at the server.

E. Any break in Ethernet communication between the server and standard client workstations on the Primary Network shall result in a notification at each workstation.

F. The network architecture shall consist of three levels of networks:
1. The Management Level Network (MLN) shall utilize BACnet/IP over Ethernet along with other standardized protocol, such as web services, html, JAVA, SOAP, XML, etc., to transmit data to non-BAS software applications and databases. The BAS Server and Operator Workstations shall reside on this level of the network architecture.
2. The Automation Level Network (ALN) shall utilize BACnet/IP over Ethernet. It shall connect BACnet Building Controllers to the BAS Server and Operator Workstations. Controllers for central plant equipment and large infrastructure air handlers shall reside on the ALN backbone BACnet/IP network. The building's Ethernet LAN shall be utilized for the ALN backbone and all ALN devices shall be connected to the building's LAN. Coordinate IP drops with Owner.
3. The Floor Level Network shall utilize BACnet/IP over Ethernet or BACnet MS/TP over RS-485 to connect all of the DDC-controlled terminal heating and cooling equipment on a floor or in a system that are controlled with BACnet Advanced Application Controllers or BACnet Application Specific Controllers. FLN devices are networked to a router that connects to the Automaton Level Network backbone.

G. Provide a router for each RS-485 subnetwork to connect them to the base building backbone level network. The router shall connect BACnet MS/TP subnetworks to BACnet over Ethernet. Routers shall be capable of handling all of the BACnet BIBBs that are listed for the controller that reside on the subnetwork.

H. The Building Level Controllers shall be able to support subnetwork protocols that may be needed depending on the type of equipment or application. Subnetworks shall be limited to :
1. BACnet MS/TP
2. Apogee FLN
3. Modbus

I. BACnet MSTP Setup rules
1. Addressing for the MSTP devices shall start at 00 and continue sequentially for the number of devices on the subnetwork.
2. No gaps shall be allowed in the addresses.

J. Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for the internetwork.

K. Controllers and software shall be BTL listed at the time of installation.

L. The system shall meet peer-to-peer communication services such that the values in any one BACnet Building Controller or BACnet Advanced Application Controller can be read or changed from all other controllers without the need for intermediary devices. The software shall provide transparent transfer of all data, control programs,

schedules, trends, and alarms from any one controller through the internetwork to any other controller, regardless of subnetwork routers.

M. Systems that use variations of BACnet using Point-to-Point (PTP) between controllers, gateways, bridges or networks that are not peer-to-peer are not allowed.

N. Remote Communications: Provide a TCP/IP compatible communication port for connection to the Owner's network for remote communications. Provide coordination with the Owner for addressing and router configuration on both ends of the remote network.

O. The system shall be installed with a 10% spare capacity on each subnetwork for the addition of future controllers.

P. On each floor, wing or major mechanical room provide an Ethernet RJ45 connection that allows connection to the BACnet network. An open port shall always be available and shall not require any part of the network to be disconnected. The location shall be accessible to the base building personnel and not in a location where the tenant can restrict the access.

Q. Distributed Control Requirements:

1. The loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.
2. The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.
3. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.
4. DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller on the network without dependence upon a central processing device. DDC Controllers shall also be able to send alarms to multiple operator workstations without dependence upon a central or intermediate processing device.
5. Operators shall have the ability to make database changes at the central system server while operator workstations are on-line without disrupting other system operations.
6. The DDC control panel shall be mounted in the same mechanical room as the equipment being controlled, or an adjacent utility room.
7. Multiple systems can be programmed on the same controller as long as they are in the same room. Systems on separate floors shall have separate controllers.
8. Remote sensors shall be wired to the control panel of the equipment it is controlling, not across the network.
9. Signals to remote motor control centers shall be hard wired to the control panel, not across the network.
10. Terminal units shall each have their own controller. Only exceptions are:
    a. Groups of reheat coils

2.1.1.3 BUILDING AUTOMATION SYSTEM SERVER HARDWARE

A. Provide a PC for the BAS Server database. Provide the latest model of the nominal speed, RAM and memory for a commercial office grade PC from a named brand manufacturer. Minimum requirements and accessories shall be:
1. Processor: Intel Core i7 series or AMD equal
2. 16GB RAM
3. 1TB Hard disk space, 7200RPM
4. Video Card with 2 GB RAM
5. At least 2 USB Ports
6. NIC Card
7. 101 key enhanced keyboard, Mouse, power strip

B. Provide a wide screen, active matrix LCD, flat panel type monitor that supports a minimum display resolution of no less than 1920 × 1080 pixels, Energy Star compliant 32-bit color. The display shall have a minimum of 21-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.

C. Locate the BAS Server in a clean, secure, dry and temperature controlled environment

D. The server shall reside on the same BACnet/IP protocol network as the System Controllers.

E. Provide software licenses for interfacing to the BAS.

F. Load software, configure and setup for viewing the BAS system.

G. Provide with the PC an operating system, such as Windows 8.1 64-or Windows 2012 R2.

H. Software: Provide the following application software licenses, preloaded on the server for the Owner: MS Office Professional, Internet Explorer, Acrobat Reader, ACAD Viewer, Microsoft IIS server. Set up an icon on the desktop to take the Owner directly to the BAS system login page.

I. Provide a copy of the software (or all software's if there are multiple) used to program and download sequences to controllers.

J. Provide a backup of the all of the programs used in the system for storage by the Owner.

2.1.1.4 OPERATOR WORKSTATION HARDWARE

A. Provide a PC for a BAS operator workstation. Provide the latest model of the nominal speed, RAM and memory for a commercial office grade PC from a named brand manufacturer. Minimum requirements and accessories shall be:
1. Processor: Intel Core i7 series or AMD equal
2. 16GB RAM
3. 320 GB Hard disk space, 7200RPM

4. Video Card with 2 GB RAM
5. At least 2 USB Ports
6. NIC Card
7. 101 key enhanced keyboard, Mouse, power strip

B. Locate operator workstation as located on plans.

C. Provide a monitor of flat panel type and shall support a minimum display resolution of no less than 1920 x 1080 pixels. The display shall have a minimum of 21-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.

D. Locate the Operator Workstations in a clean, secure, dry and temperature controlled environment

E. Provide software licenses for interfacing to the BAS.

F. Load software, configure and setup for viewing the BAS system.

G. Provide the PC with an operating system, such as Windows 8.1 or other operating systems compatible with the BAS software.

H. Software: Provide the following application software licenses, preloaded on the client for the Owner: MS Office Professional, Internet Explorer, Acrobat Reader, CAD Viewer. Set up an icon on the desktop to take the Owner directly to the BAS system login page.

2.1.1.5 BACNET ADVANCED WORKSTATION SOFTWARE

A. Interface Description

1. The software shall provide, as a minimum, the following functionality:
   a. Real-time graphical viewing and control of the BMS environment.
   b. Reporting of both real-time and historical information.
   c. Scheduling and override of building operations.
   d. Collection and analysis of historical data.
   e. Point database editing, storage and downloading of controller databases.
   f. Configuration of and navigation through default and personalized hierarchical "tree" views that include workstation and control system objects.
   g. Event reporting, routing, messaging, and acknowledgment.
   h. Definition and construction of dynamic color graphic displays.
   i. Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
   j. On-screen access to User Documentation, via online help or PDF-format electronic file.
   k. Automatic database backup at the operator interface for database changes initiated at Building Controllers.
   l. Display dynamic trend data graphical plot.
      1) Must be able to run multiple plots simultaneously.
      2) Each plot must be capable of supporting 10 pts/plot minimum.
      3) Must be able to command points from selection on dynamic trend plots.
      4) Must be able to plot real-time data without prior configuration.

5) Must be able to plot both real-time and historical trend data simultaneously.

m. Program editing
n. Transfer trend data to third-party spreadsheet software
o. Scheduling reports
p. Operator Activity Log

2. Operator interface software shall minimize operator training through the use of user-friendly and interactive graphical applications.
3. Users must be able to build multiple, separate, personalized hierarchical "tree" views that represent the workstation, control systems, geographical facility layouts, and mechanical equipment relationships.
4. 256-character point identification (names) must be supported to provide clearly descriptive identification.
5. On-line help must be available.
6. The user interface shall display relevant information for a selection in multiple panes of a single window without the need for opening multiple overlapping windows on the desktop
7. Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation.
8. Software navigation shall be user friendly by utilizing "forward & back" capability between screens and embedded links to graphics, documents, drawings, trends, schedules, as well as external documents (.doc, .pdf, .xls, etc.) or web addresses that are related to any selected object.
9. Primary selection of objects in the operator interface software shall be available from user defined hierarchical Views, from graphics, or from events in an Event List.
10. Secondary selection of objects in the operator interface software shall be available from links to any objects or external documents related to the primary selection.
11. Links to information related to any selected objects shall be displayed in a consistent manner and automatically defined based on where an object is used in the system.
12. The operator workstation shall be capable of displaying web pages and common document formats (.doc, .xls, .pdf) within the operator workstation application.
13. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously.
14. System database parameters shall be stored within an object-oriented database.
15. Standard Windows applications shall run simultaneously with the BMS software.
16. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BMS alarms and monitoring information.
17. Provide automatic backup and restore of all Building Controller databases on the workstation hard disk.
18. System configuration, programming, editing, graphics generation shall be performed on-line from the operator workstation software.
19. User shall be able to edit point configuration of any configurable BACnet point that resides in a devices that supports external editing.
20. The software shall also allow the user to configure the alarm management strategy for each point.

21. Users shall have the ability to view the program(s) that is\are currently running in a Building Controller. The display shall mark the program lines with the following: disabled, comment, unresolved, and trace bits.

B. Certifications and Approvals
1. BAS software shall have been tested against the following norms and standards:
   a. BACnet Revision 1.13, certified by BACnet Testing Laboratory as BACnet Advanced Workstation Software (BTL B-AWS)
   b. IT security compliant with the ISA-99/IEC 62443 Security Level: SL1
   c. OPC DA V2.05a and V3.0 Server, certified by the OPC Foundation certification program
   d. UL-listed to UL864 9th edition Standard for Control Units and Accessories (when installed on a UL-approved computer)

C. Client-Server Connectivity
1. Client sessions must be allowed to run on the server and on other devices connected to the server via Intranet, Extranet, or Internet connections.
2. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the owner as required to support remote access features.
3. The following client options must be supported
   a. Installed Client.
      1) Software application installed from installation media on to the client machine.
      2) Installed client software must be configurable to allow it to run in a Closed Mode such that the BAS software can lock down the client machine and prevent users without permission from minimizing the application or running other Windows applications that might cover the BAS software interface.
      3) Communication between the server and Installed Clients must be monitored so that any break in communication between the server and an installed client results in notification at the Server and Installed Client machine
      4) Installed client machines communicate directly with the BAS server
   b. Web Client.
      1) Software that runs in a browser on the client machine as a Full Trust client application.
      2) Connected to the BAS software server via Microsoft IIS Server.
   c. Windows App.
      1) Software application downloaded from the BAS server to run on the client machine like an installed application
      2) Application must be automatically updated whenever new apps are available at the server.
      3) Connected to the BAS software server via Microsoft IIS Server.
4. Each of the client options shall provide the same functionalities including operation and configuration capabilities.

D. Access Rights and User Privileges
1. Access to any client user session must be password protected.
2. Users shall be able to create local user accounts specific to the application software.

3. Users shall be able to link application user accounts to Active Directory user accounts for consistent management with domain user accounts.
4. Operator-specific password access protection shall be provided to allow the administrator/manager to limit users' workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned user name and password.
5. Operator privileges shall follow the operator to any workstation logged onto.
6. The administrator or manager shall be able to further limit operator privileges based on which console an operator is logged on to.
7. The administrator or manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BMS workstation application.

E. Activity Logging
1. The operator interface software shall maintain a log of the actions of each individual operator.
2. The software shall provide an application that allows querying based on object name, operator, action, or time range.
3. The software shall provide the ability to generate reports showing operator activity based on object name, operator, action, or time range.

F. Graphics Application
1. All graphics shall be available with the same look and functionality whether they are displayed at an installed client console or in a browser.
2. User shall be able to add/delete/modify system graphics for floor plan displays and system schematics for each piece of mechanical equipment (including, air handling units, geothermal water systems, and room level terminal units) from standard user interface without the need of any external or specialized tools.
3. The software shall include all necessary tools and procedures for the user to create their own graphics.
4. The software shall provide the user the ability to display real-time point values by animated motion or custom picture control visual representation.
5. The software shall provide animation that depicts movement of mechanical equipment, or air or fluid flow.
6. The software shall provide users the ability to depict various positions in relation to assigned point values or ranges.
7. The software shall provide the ability to add custom gauges and charts to graphic pages.
8. The software must include a library of at least 400 standard control application graphics and symbols for visualizing common mechanical systems, including fans, valves, motors, AHU systems, standard ductwork diagrams, piping, and laboratory symbols.
9. The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.
10. The Graphics application shall be capable of automatically assigning the appropriate symbol for an object (point) selected to be displayed on the graphic

based on what the object represents (fan, duct sensor, damper, etc.) when the object is placed on a graphic.

11. The Graphics application shall allow a user to manually override the automatically assigned symbol for an object when a different symbol is desired.
12. The user shall have the ability to add custom symbols to the symbol library.
13. The software shall permit the importing of AutoCAD or scanned pictures for use in graphics.
14. Graphics must be automatically associated to any points or system objects that are rendered on the graphic, so that selection of a system object will allow a user to simply navigate to any associated graphic, without the need for manual association.
15. The software must allow users to command points directly off graphics application.
16. Graphic display shall include the ability to depict real-time point values dynamically with text or animation.
17. Navigation through various graphic screens shall be optionally achieved through a hierarchical "tree" structure
18. Graphics viewing shall include dynamic pan zoom capabilities.
19. Graphics viewing shall include the ability to switch between multiple layers with different information on each layer.
20. Graphics shall include a decluttering capability that allows layers to be programmatically hidden and displayed based on zoom level.
21. Graphics shall be capable of displaying the status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
22. The software must provide the ability to create dashboard views consisting of gauges and charts that graphically display system and/ or energy performance.

G. System Performance

1. Comply with the following performance requirements:
   a. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 5 seconds.
   b. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 5 seconds.
   c. Object Command: Reaction time of less than 5 seconds between operator command of a binary object and device reaction.
   d. Object Scan: Transmit change of state and change of analog values to control units or workstation within 5 seconds.
   e. Alarm Response Time: Annunciate alarm at workstation within 2 seconds. Multiple workstations must receive alarms within five seconds of each other.
   f. Program Execution Frequency: Programmable controllers shall execute DDC PI control loops, and scan and update process values and outputs at least once per second.
   g. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
      1) Water Temperature: Plus or minus 1 deg F.
      2) Water Flow: Plus or minus 5 percent of full scale.
      3) Water Pressure: Plus or minus 2 percent of full scale.
      4) Space Temperature: Plus or minus 1 deg F.
      5) Ducted Air Temperature: Plus or minus 1 deg F.
      6) Outside Air Temperature: Plus or minus 2 deg F.

7) Dew Point Temperature: Plus or minus 3 deg F.
8) Temperature Differential: Plus or minus 0.25 deg F.
9) Relative Humidity: Plus or minus 2 percent.
10) Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
11) Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
12) Airflow (Terminal): Plus or minus 10 percent of full scale.
13) Air Pressure (Space): Plus or minus 0.01-inch wg.
14) Air Pressure (Ducts): Plus or minus 0.1-inch wg.
15) Carbon Monoxide: Plus or minus 5 percent of reading.
16) Carbon Dioxide: Plus or minus 50 ppm.
17) Electrical: Plus or minus 5 percent of reading.

H. Reports
1. The software must allow reports shall be executed on demand.
2. The software must allow reports shall be executed via pre-defined schedule.
3. As a minimum, the system shall allow the user to easily obtain the following types of reports:
   a. A general listing of all or selected points in the network
   b. A status report showing present value and alarm status
   c. List of all points currently in alarm
   d. List of all points currently in override status
   e. List of all disabled points
   f. System diagnostic reports including, list of Building panels on line and communicating, status of all Building terminal unit device points
   g. List of alarm strategy definitions
   h. List of Building Control panels
   i. Point totalization report
   j. Point Trend data listings
   k. Initial Values report
   l. User activity report
   m. Event history reports

I. Scheduling
1. The software shall provide a calendar type format for simplification of time and date scheduling and overrides of building operations.
2. The software shall support the definition of BACnet schedules that are defined at the workstation and are downloaded to Building Controller to ensure time equipment scheduling when PC is off-line, such that the operating software is not required to execute time scheduling. The software must provide the following capabilities for BACnet scheduling capabilities as a minimum:
   a. Fully support all BACnet Schedule, Calendar, and Command objects.
   b. Daily and Weekly schedules
   c. Ability to combine multiple points into a logical Command Groups for ease of scheduling (e.g., all Building 1 lights)
   d. Ability to schedule for a minimum of up to ten (10) years in advance.
3. The software shall support the definition of schedules that are configured and executed to run at the workstation, to support scheduling of workstation software activities and to support field systems that do not include internal scheduling mechanisms. The software must provide the following capabilities for BACnet scheduling capabilities as a minimum:

a. Schedule predefined reports
b. Schedule Trend collections
c. Schedule automated system backups
d. Schedule commands to be sent to field panels
e. Daily and weekly schedules
f. Setting up and executing Holiday schedules
g. Ability to combine multiple points into a logical Command Groups for ease of scheduling (e.g., all Building 1 lights)
h. Ability to schedule for a minimum of up to ten (10) years in advance.

4. The software shall provide the ability for users to override regular weekly schedules through menu selection, graphical mouse action or function key.
5. The software shall provide a timeline view, showing the results of any number of combined selected workstation and field panel controller schedules for an overview of facility operation.

J. Trending

1. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time.
2. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable.
3. Trend data shall be collected and stored on hard disk for future diagnostics and reporting.
4. Automatic Trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of equipment.
5. System shall support trending in the same device as the monitor point or in an external device.
6. The software must support configuration of panels that have a trending level threshold, above which the data will be automatically uploaded to the BMS server to prevent overwriting the data in the field panel. The trending level will be user defined in % of available space (e.g., automatically upload when the trend buffer is at 75% of allocated space).
7. Trend data reports shall be provided to allow the user to view all trended point data.
8. Trend data reports may be customized to include individual points or predefined groups of selected points.
9. The software shall allow the user to view real-time trend data on trend graphical plot displays.
    a. A minimum of ten points may be plotted
    b. A combination of real-time and historical data may be plotted
    c. Dynamic graphs shall continuously update point values
    d. At any time the user may redefine sampling times or range scales for any point
    e. The user may pause the display and take "snapshots" of plot screens to be stored on the workstation disk for future recall and analysis
    f. Exact point values may be viewed on the Trend plot
    g. Trend graphs may be printed
    h. Operator shall be able to command points by selecting them on the trend plot. Operator shall be able to zoom in on a specific time range within a plot.
    i. The Trend Viewer must allow users to configure separate left and right axis for easier differentiation of point values.

j. The Trend Viewer must allow users to display historical data for the same group of points at different times simultaneously for easy comparison of system behavior over time.

K. Event Management

1. Event Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each event: name, value, event time and date, event status, priority, acknowledgement information, and alarm count.
2. Only events for which the logged on user has privileges to view shall be displayed on each workstation.
3. The software shall provide the ability to users to limit the list of events displayed at each workstation (e.g. only show fire events at this workstation, no matter who is logged on)
4. Each event shall have the ability to sound an audible notification based on the category of the event.
5. Event List shall have the ability to list and sort the events based on event status, point name, ascending or descending activation time.
6. Directly from the Event List, the user shall have the ability to acknowledge, silence the event sound, print, or erase each event.
7. The interface shall provide the option to inhibit the erasing of active acknowledged events, until they have returned to normal status.
8. The user shall have the ability to navigate to all information related to a selected point in order to command, launch an associated graphic or trended graphical plot, or run a report on a selected point directly from the Event List.
9. Each event shall have a direct link from the Event List to further user-defined point informational data.
10. The user shall have the ability to also associate real-time electronic annotations or notes to each event.
11. Software shall provide the option to configure detailed operating procedures that guide a user through predetermined standard operating procedures for handling critical events. Users shall be able to log completion of each operating step as it is performed.

L. Remote Notification (RENO)

1. Workstations shall be configured to send out messages to numeric pagers, alphanumeric pagers, SMS (Simple Messaging Service, text messaging) Devices, and email accounts based on a point's alarm condition.
2. Email notification must support POP3, IMAP, and SMTP with SSL/TSL
3. Communication with external software must be encrypted.
4. There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices which can receive messages from the system.
5. On a per point basis, system shall be configurable to send messages to an individual or group and shall be configurable to send different messages to different remote devices based on alarm message priority level.
6. System must be configurable to send messages to an escalation list so that if the first device does not respond, the message is sent on to the next device after a configurable time has elapsed.

7. Workstation shall have the ability to send manual messages allowing an operator to type in a message to be sent immediately.
8. Workstation shall have a feature to send a heartbeat message to periodically notify users that they have communication with the system.

M. External Data Access
1. The software shall provide the ability to expose configuration properties and real-time values through CSV files, OPC DA, OPC UA, or REST-based Web Services.
2. The software shall provide the ability for external applications to change configuration and real-time values through OPC DA, OPC UA, or REST-based Web Services.
3. The software shall provide the ability for external applications to access historical Trend data through CSV files or REST-based Web Services.
4. External data access must be secured using the level of permissions configured for users and operator workstations.
5. Web service interfaces must allow for exchanging data (object's values, events and trend series) between workstation and external applications such as facility management systems, enterprise applications, mobile applications or other value-added services.

N. Licensing
1. Software licensing must be allowed to be bound to a dongle or to physical PC hardware.
2. User licenses from all client types shall be from a common pool of client licenses. Licenses for installed and browser-based clients shall not be in separate pools.
3. Provide the number of client licenses as called for here or in the Sequence of Operations.

O. Data Security
1. The BAS software must allow that all communication paths between clients and the server are encrypted and protected against replay attacks as well as data manipulation.
2. Any runtime data transfer between the system server and Web Server (IIS) must be allowed to be encrypted by Desigo CC.
3. Communication between any Web Server (IIS) and the Web Clients must be allowed to be encrypted.
4. Passwords must be handled with encrypted storage and transmission
5. The software must support the use of public domain algorithms for cryptographic functions, including AES, DiffieHellmann, RSA, and SHA-2. No self-coded algorithms shall be allowed.
6. All symmetrical encryption must use 256 bit AES or stronger.
7. All asymmetrical encryption must use 2048 bit or stronger.
8. The software must support the use of commercial certificates for securing client-server communications.
9. The software must support the use of self-signed certificates to allow local deployments without the overhead of obtaining commercial certificates.
10. When using self-signed certificates, the owner of the Desigo CC system is responsible for maintaining their validity status, and for manually adding them to and removing them from the list of trusted certificates.

P. BACnet
1. The Operator Workstation Software shall be capable of BACnet IP communications.
2. The Operator Workstation Software shall have demonstrated interoperability during at least one BTL Interoperability Workshop.
3. The Operator Workstation Software shall have demonstrated compliance to BTL B-AWS device classification through BTL listing as specified in ANSI/ASHRAE 135 under revision 1.13 or higher.
4. The BAS Server and Workstations shall support the following Data Link Layers:
   a. BACnet IP Annex J
   b. BACnet IP Annex J Foreign Device
   c. ISO 8802-3, Ethernet (Clause 7)
5. The BAS Server and Workstations shall support transmitting and receiving segmented messages.
6. The BAS Server and Workstation shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.

2.1.1.6 DIRECT DIGITAL CONTROLLER SOFTWARE

A. Provide a full capability user license to the owner for the operator to be able to see, modify, create, upload, download and save control programs to the DDC controllers.

B. The software program shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer or another controller for execution.

C. Point naming and communication format:
1. All points, panels, and programs shall be identified by a 30-character name. All points shall also be identified by a 16-character point descriptor. The same names shall be displayed at both Building Controller and the Operator Interface.
2. All digital points shall have a consistent, user-defined, two-state status indication with 8 characters minimum (e.g., Summer, Enabled, Disabled, Abnormal).
3. The Building Controller Software shall be capable of BACnet communications. The BACnet Building Controller (B-BC) shall have demonstrated interoperability during at least one BTL Interoperability Workshop, have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, Annex L.

D. System Security
1. User access shall be secured using individual security passwords and user names.
2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
3. Building Controllers shall be able to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any Operator Interface or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the Operator Interface or portable terminal. Passwords and priorities for every point shall be fully programmable and adjustable.

4. User Log On/Log Off attempts shall be recorded.
5. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
6. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the DDC controller software.

E. Alarm Management
1. Alarm management shall be provided within the controller software to monitor and direct alarm information to operator devices.
2. Each Building Controller shall perform distributed, independent alarm analysis, minimize network traffic and prevent alarms from being lost. At no time shall the Building Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
3. Conditional alarming shall allow generation of alarms based upon user defined multiple criteria.
4. An Alarm "shelving" feature shall be provided to disable alarms during testing. (Pull the Plug, etc.).
5. Binary Alarms. Each binary alarm object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
6. Analog Alarms. Each analog alarm object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
7. All alarm shall include the point's user-defined language description and the time and date of occurrence.
8. Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be able to start programs, print reports, be logged in the event log, generate custom messages, and display graphics.
9. The user shall be able to add a 200-character alarm message to each alarm point to more fully describe the alarm condition or direct operator response. Each Building Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assigned to any number of points in the Controller.
10. Operator-selected alarms shall be capable of initiating a trigger to an advanced annunciation, such as text, email, etc.
11. An alarm history log shall report the start of the alarm condition, acknowledgement by a user and return of the alarm to normal condition.

F. Scheduling:
1. Provide a comprehensive menu driven program to automatically start and stop designated multiple objects or events in the system according to a stored time.
2. Schedules shall reside in the building controller and shall not rely on external processing or network.
3. It shall be possible to define a group of objects as a custom event (i.e., meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.
4. The operator shall be able to define the following information:
   a. Time, day
   b. Commands such as on, off, auto, etc.

c. Time delays between successive commands.
d. There shall be provisions for manual overriding of each schedule by an authorized operator.

5. It shall be possible to schedule calendar-based events up to one year in advance.

2.1.1.7 BACNET BUILDING CONTROLLERS

A. Provide all necessary hardware for a complete operating system as required. The Building Controller shall be able to operate as a standalone panel and shall not be dependent upon any higher level computer or another controller for operation.

B. Basis of design is Siemens PX Modular and Compact Controllers (PXC). **Approved alternates are Distech and Johnson Controls (Addendum 2).**

C. This controller shall have the BTL listing and meet the BACnet device profile of a Building Controller (B-BC).
1. The Building Level Controller shall have the capability to act as a BACnet router between MS/TP subnetworks and BACnet/IP.

D. Computing power and memory minimum:
1. A 32-bit, stand-alone, multi-tasking, multi-user, real-time 100MHz digital control microprocessor module.
2. Inputs shall be 16-bit minimum analog-to-digital resolution
3. Outputs shall be 10-bit minimum digital-to-analog resolution
4. Memory module (24 Megabyte, minimum) to accommodate all Primary Control Panel software requirements, including but not limited to, its own operating system and databases (see Controllers Software section), including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, dial-up communications.
5. Real time clock and battery
6. Data collection/ Data Trend module sized for 10,000 data samples.
7. Flash Memory Firmware: Each Building Level Control Panel shall support firmware upgrades without the need to replace hardware.

E. Input and Output Points Hardware
1. Input/output point modules as required including spare capacity.
2. Input/output point modules shall have removable terminal blocks.
3. Monitoring of the status of all hand-off-auto switches.
4. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
5. Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
6. Graduated intensity LEDs or analog indication of value for each analog output.
7. HOA (hand-off-auto module) with software configurability and LED status indicators shall be provided for all digital outputs.

F. Code compliance
   1. Approvals and standards: UL916; CE; FCC
   2. Provide UL864-UUKL where called for in the sequences of operations.

G. Accessories:
   1. Appropriate NEMA rated metal enclosure.
   2. Power supplies as required for all associated modules, sensors, actuators, etc.

H. The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on-board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. Provide hand/off/auto switch for each digital output, including spares.

I. Each Building Level Control Panel shall continuously perform self-diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.

J. Panel setup, point definitions and sequencing diagrams shall be backed up on EEPROM memory.

K. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.

L. Building Level control panels shall provide at least two serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal communications, operation of permanently connected modems, printers or terminals.

M. Building Level Controllers shall have the capability to serve as a gateway between Modus subnetworks and BACnet objects. Provide software, drives and programming.

N. Isolation shall be provided at all primary control panel terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

O. Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be “future” on drawings and 10% more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

P. Environment.
   1. Controller hardware shall be suitable for the anticipated ambient conditions.

2. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
3. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
4. Controller hardware shall be optionally suitable for rooftop environments.

Q. Immunity to power and noise.
1. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
3. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
   a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V.
   b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
   c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.
   d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
4. Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:
   a. IEEE Standard 587 1980
   b. UL 864 Supply Line Transients
   c. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

2.1.1.8 BACNET ADVANCED APPLICATION CONTROLLERS

A. Provide all necessary hardware for a complete operating system as required. The Advanced Application level control panel shall be able to operate as a standalone panel and shall not be dependent upon any higher level computer or another controller for operation.

B. Basis of design is Unitary Equipment Controller (PXCxx-UCM).

C. The Advanced Application Controller Software shall be capable of BACnet communications. The BACnet Advanced Application Controller (B-AAC) shall have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004 or ANSI/ASHRAE 135-2008.

D. Communication:
1. BAS Network: The Advanced Application Controller shall support the following Data Link Layers:
   a. MS/TP Master
2. Serial Communication: Temporary use of portable devices shall not interrupt the BAS communication, nor the normal operation of permanently connected printers or terminals.

a. Provide at least one EIA-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals.
b. A USB port shall alternatively be available to support local HMI tools connection.

E. Software
1. The software programs specified in this section shall be provided as an integral part of Advanced Application Controllers and shall not be dependent upon any higher level computer or another controller for execution.
2. Advanced Application Controllers shall have the ability to perform energy management routines including but not limited to
   a. scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides
   b. automatic daylight savings time switch over
   c. night setback control
   d. economizer switch over using enthalpy, dry bulb or a combination
   e. temperature-compensated duty cycling
   f. heating/cooling interlock
   g. supply temperature reset
   h. priority load shedding
   i. power failure restart
3. System Security in the Field Panel
   a. User access shall be secured using individual security passwords and user names.
   b. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
   c. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
   d. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the field panel.
4. User Defined Control Applications:
   a. Controllers shall be fully-programmable. Controllers shall execute custom, job-specific sequences to automatically perform calculations and special control routines. Factory installed or pre-configured sequences shall only be allowed if they exactly match the sequence specified herein.
   b. Programs shall combine control logic, control loop algorithms, and energy management routines
   c. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.
   d. Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task oriented information from the user manual.

F. Input/Outputs
1. Inputs shall be 16-bit minimum digital resolution
2. Outputs shall be 10-bit minimum digital resolution
3. The following I/O port types shall be available on the controller
   a. Universal Input (software configurable):

1) Digital Input choices:
   a) Pulse Accumulator
   b) Contact Closure Sensing
   c) Dry Contact/Potential Free inputs only
   d) Digital Input (10 ms settling time)
   e) Counter inputs up to 20 Hz, minimum pulse duration 20 ms (open or closed)
2) Analog Input Choices:
   a) 0-10 Vdc
   b) 4-20 mA
   c) 1K Ni RTD @ 32°F (Siemens, JCI, DIN Ni 1K)
   d) 1K Pt RTD (375 or 385 alpha) @ 32°F
   e) 10K NTC Type 2 or Type 3 Thermistor
   f) 100K NTC Type 2 Thermistor

b. Universal Input or Output (software configurable):
   1) All of the above input types
   2) Analog Output Types:
      a) 0 to 10 Vdc @ 1 mA max

c. Super Universal Input or Output (software configurable):
   1) All of the above input types
   2) All of the above output types
   3) Super digital output type:
      a) 0 to 24 Vdc, 22 mA max. (for controlling pilot relay)
   4) Super Analog Output Choices:
      a) 0 to 20 mA @ 650 Ω max.

4. Provide software configurable I/O ports such that a programmer make a port either an input or an output

G. Each System Level Control Panel shall, at a minimum, be provided with:

1. Appropriate NEMA rated metal enclosure.
2. A 32-bit,multi-tasking, real-time 100 MHz digital control microprocessor with plug-in, enclosed processors.
3. Each Advanced Application Controller shall have sufficient memory, a minimum of 24 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, and operator I/O.
4. Real time clock and battery
5. Data collection/ Data Trend module sized for 10,000 data samples.
6. Power supplies as required for all associated modules, sensors, actuators, etc.
7. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
8. Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
9. Each control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
10. Graduated intensity LEDs or analog indication of value for each analog output.

H. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for the operating system software and firmware.
   1. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
   2. Brownout protection and power recovery circuitry protect the controller board from power fluctuations.
   3. Battery backup shall be provided to support the real-time clock for 10 years
   4. The program and database information stored SDRAM memory shall be battery backed for a minimum of 30 days and up to 60 days. This eliminates the need for time consuming program and database re-entry in the event of an extended power failure.

I. Database Restore: Each AAC controller shall automatically save the latest programmed database. The controller shall be able to automatically restore a lost or corrupt database without involvement from the operator.

J. Each System Level Control Panel shall continuously perform self-diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.

K. System Level control panels shall provide at least two RS-232C serial data communication ports for operation of operator I/O devices such as operator terminals, and additional memory. Control panels shall allow temporary use of portable operator interface devices without interrupting the normal communications.

L. Immunity to noise.
   1. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
   2. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
      a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V.
      b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
      c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.
      d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
   3. Isolation shall be provided at all Advanced Application Controller's AC input terminals to suppress induced voltage transients consistent with:
      a. IEEE Standard 587 1980
      b. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

M. Agency Compliance
   1. UL UL916 PAZX (all models)
   2. UL916 PAZX7 (all models)
   3. FCC Compliance CFR47 Part 15, Subpart B, Class B

N. Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be "future" on drawings and 10% more of each point type. Provide all hardware

modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

2.1.1.9 BACNET APPLICATION SPECIFIC CONTROLLERS (DXR)

A. Each Application Specific Controller shall operate as a stand-alone controller capable of performing its user selectable control routines independently of any other controller in the system. Each Application Specific Controller shall provide standard applications and programmability to provide both reliability and flexibility. Each application specific controller shall be a microprocessor-based, multi-tasking, digital control processor.

B. Basis of design is the programmable Siemens DXR controller.

C. Configurable control applications. Each Application Specific Controller model must have a set of pre-loaded, selectable and field-adjustable control applications appropriate for the secondary HVAC equipment that the controller model is intended to control. Specific applications must be configurable to meet the user's control strategy requirements, allowing for additional system flexibility.

D. The Application Specific Controller shall include all point inputs and outputs necessary to perform the specified HVAC control sequences. The controller shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control output signals shall not be acceptable. Controllers shall provide outputs utilized either for two-state, modulating floating, or proportional control, allowing for additional system flexibility.

1. Analog inputs shall be software configurable to accept sensors using 0-10v (such as RH or CO2 sensors), NTC3k, NTC10k, NTC100k, Ni1000, PT1K 385, and resistance sensors of 1000Ω, 2500 Ω, 10K Ω, and 100k Ω . 24vDC power to drive active sensors shall be an option available from the controller.
2. Digital input
3. Analog Outputs shall support 0-10v HVAC control signals.
4. Digital outputs shall be AC 24V high-side switching triacs, able to switch loads of 250 mA / 6 VA per output.
5. Every installed Application Specific Controller shall be prepared for the addition of occupancy, CO2 and humidity sensors
6. Additional sensors and output modules for occupancy, lighting and shade control within the same space as the HVAC control shall be connected as needed via a sub-network connection on each Application Specific Controller
7. The Application Specific Controller shall be compatible with a Control Manufacturer Room Unit which combines a display with CO2, temperature and humidity sensing in 1 wall device.
8. The Application Specific Controller shall be compatible with a Control Manufacturer Room Unit which combines a display with temperature sensing and configurable switches for lighting, shade and scene control in 1 wall device.

E. Application Specific Controller communication

1. Communication over floor level network shall be BACnet over MS/TP or BACnet IP over Ethernet.

2. A maximum of 96 controllers may be configured on individual BACnet MS/TP networks.
3. Each controller that uses BACnet IP shall provide at least two Ethernet ports allowing the controllers to be wired in a daisy-chain configuration of up to at least 20 controllers per chain, utilizing standard Ethernet cables of up to 300ft in length between each controller.

F. The Application Specific Controller shall have the BTL listing and meet the BACnet device profile of an Application Specific Controller (B-ASC) as specified in ANSI/ASHRAE 135-2012. The Application Specific Controller shall support the following Data Link Layers:
   a. BACnet MS/TP Master (Clause 9)
   b. BACnet IP, Foreign Device

G. Each Application Specific Controller shall, at a minimum, be provided with:
1. Appropriate NEMA rated enclosure
2. Power supplies as required for all associated modules, sensors, actuators, etc.
3. Each controller measuring air volume shall include a differential pressure transducer
4. Approvals and standards: UL916 PAZX; CUL; FCC

H. Each Application Specific Controller shall continuously perform self-diagnostics on all hardware and secondary network communications. The Application Specific Controller shall provide both local and remote annunciation of any detected component failures or repeated failure to establish communication to the system.

I. Power Supply. The Application Specific controller shall be powered from a 24 VAC source and shall function normally under an operating range of -15% / +20%.

J. All controller configuration settings and programs shall be stored in non-volatile memory. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.

K. Environment. The controllers shall function normally under ambient conditions of 23 to 122°F (-5 to 50°C) and 5% to 95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the circuit board assembly.

2.1.1.10 CONTROL PANELS

A. Controllers in mechanical rooms shall be mounted in NEMA 1 enclosures.

B. Controllers in areas where moisture is a concern shall be mounted in NEMA 12 enclosures.

C. Controllers installed outdoors shall be mounted in NEMA 4X enclosures. Provide heaters where freezing temperatures are normally experienced.

D. Mount on walls at an approved location or provide a free standing rack.

E. Panels shall be constructed of 16 gauge, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with ANSI 61 gray polyester-powder painted finish, UL listed. Provide common keying for all panels.

F. Provide power supplies for control voltage power.

G. Dedicate 1 power supply to the DDC controller. Other devices shall be on a separate power supply, unless the power for the control device is derived from the controller terminations.

H. Power supplies for controllers shall be a transformer with a fuse or circuit breaker. Power supplies for other devices can be plain transformers.

I. All power supplies for 24V low voltage wiring shall be class 2 rated and less than 100VA. If low voltage devices require more amps, then provide multiple power supplies. If a single device requires more amps, then provide a dedicated power supply in a separate enclosure and run a separate, non-class 2 conduit to the device.

J. Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.

K. All devices in a panel shall be permanently mounted, including network switches, modems, media converters, etc.

L. Provide a pocket to hold documentation.

PART 3 - EXECUTION

3.1.1.1 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.

C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

3.1.1.2 INSTALLATION

A. Provide all relays, switches, and all other auxiliaries, accessories and connections necessary to make a complete operable system in accordance with the sequences specified. All field wiring shall be by this contractor.

B. Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.

C. Mount surface-mounted control devices on brackets to clear the final finished surface on insulation.

D. Install equipment level and plumb.

E. Install control valves horizontally with the power unit up.

F. Unless otherwise noted, install wall mounted thermostats and humidistat 60" above the floor measured to the center line of the instrument, or as otherwise directed by the Architect.

G. Install averaging elements in ducts and plenums in horizontal crossing or zigzag pattern.

H. Install damper motors on outside of duct in protected areas, not in locations exposed to outdoor temperatures.

I. Install labels and nameplates on each control panel listing the name of the panel referenced in the graphics and a list of equipment numbers served by that panel.

J. Furnish hydronic instrument wells, valves, and other accessories to the mechanical contractor for installation.

3.1.1.3 GRAPHIC DISPLAY GENERATION

A. All software shall be capable of providing color graphics. All software shall include a graphical viewing and control environment and definition and construction of dynamic color graphic displays.

B. Provide a main default screen showing the basic layout of the building. Each color graphic screen shall have transfer links to allow the building operator to transfer between system associated screens (both forward and backward), as well as a transfer link back to the main default screen.

C. Basic CAD floor plans with layers for walls, windows, low pressure ductwork only, supply diffusers and room numbers shall be provided for all terminal units. Floor plans shall show the location of each space temperature sensor with a dashed line to the associated terminal unit. Display in real time the difference between the space temperature and the current setpoint.

1. Display the
    a. cooling %,
    b. heating % (if applicable)
    c. current CFM of each terminal unit.

2. Provide a transfer link for each terminal unit to allow the operator to access the flow graphic for each individual terminal unit. Use a different color to shade the background area for each part of a floor plan graphic served by a different air handling unit.

D. Thermal floor plan graphics:
1. Show heating and cooling zones throughout the building in a range of colors (minimum 5) that provide a visual display of temperatures relative to their respective setpoints. The colors shall be updated dynamically as zones' comfort conditions change. Locations of space sensors shall also be shown for each zone. Floor plan humidity's shall be represented similarly to zone temperatures. Setpoint adjustment and color band displays shall be provided as a tool for user adjustment.
2. These full screen plans shall be accessible by rolling over the floor on the building elevation rendering. This will provide the viewer a quick and accurate overview of which zones are at setpoint, near setpoint, or need attention.
3. The viewer may then click on any zone to be brought to the terminal unit that is related to that zone. Rolling over any zone will bring up the zone description and temperature in a pop-up flag. Flags are used to keep the zone information legible regardless of how small the zone is depicted on the plan
4. All floor plans shall be vector based to allow for zooming in and out of floor plans without pixelization.
5. If zone lighting controls are tied into the BAS, then produce the same floor viewing and control for lights.
6. If a Web-based graphical interface is specified, then the floor plan graphics shall be accessible through the Web Browser Interfaces.

E. All control set points shall be easily adjustable from the system's color graphic screen by operators with the proper access level. Each controlled point on the BAS operator workstation color graphic screens shall have the set point indicated along with the actual controlled variable reading (preferred set point on top and actual reading on bottom). All points shall indicate the associated engineering unit. All analog outputs points shall indicate engineering units such as "%-open" or "%-closed" as required by the application. All normally-closed or normally-open points shall indicate the normal position (such as "N.C." or "N.O." next to the controlled device).

F. Provide system color graphics for each HVAC system and for each electrical, plumbing and/or piping system that is monitored and/or controlled by the BMS. Provide scaled floor plans indicating equipment location, service, and system data as required.

G. Provide color graphic floor plan displays and system schematics for each piece of mechanical equipment, including but not limited to air handling units, chilled water systems and hot water systems to optimize system performance analysis and speed alarm recognition.

H. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.

I. The windowing environment of the operator interface shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to

allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

1. Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols.
2. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility.

J. Provide an automatically updated, dynamic display of the site-specific BMS architecture indicating the status of primary and secondary controllers.

K. Provide a separate dynamic display page of each HVAC (AHU, AC, chiller, cooling tower, fuel oil, etc.), electrical, and/or plumbing system connected to the BMS.

L. Provide a separate dynamic display page of each piece of terminal equipment (VAV box, fan coil unit, etc.) connected to the BMS.

M. Provide an additional dynamic, graphic display pages as required by the operating staff to further assist in daily system operations.

N. Graphics shall incorporate all system integration points communicated via hardware or software gateways and/or interfaces. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.

O. Each graphic shall have a "BACK" button and a "HOME" or "MAIN" button located in the same location on all graphics.

P. The operator shall be able to clearly distinguish the difference between the following types of points on a graphic either by color, shape, icon or text label:

1. Real-time sensor reading
2. Setpoint
3. Manually set vs. program set Setpoint
4. Real-time output reading
5. Manually Overridden or commanded output vs program set output
6. Status feedback from a piece of equipment vs the output command

3.1.1.4 ELECTRICAL WIRING SCOPE

A. This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor. If power circuits are shown on the electrical drawings, this contractor shall continue the power run to the control device. If power circuits are not shown, this contractor shall coordinate with the electrical contractor to provide breakers at distribution panels for power to controls. This contractor is then responsible for power from the distribution panel.

1. Coordinate panel locations. If enclosures for panels are shown on the electrical drawings, furnish the enclosures according to the electrician's installation schedule.

B. This contractor shall not be responsible for power to control panels and control devices that are furnished by others, unless it is part of the control interlock wiring.

C. This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.

D. Provide network wiring for equipment that is called to be integrated to the BAS.

3.1.1.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. All low voltage control wiring shall be class 2. Control wiring that is not class 2 shall be run in separate conduits from class 2 wiring.

B. Floor level network wiring between terminal units can be combined with thermostat and other low voltage wiring in the same conduit. All other network wiring shall be in dedicated conduits.

C. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes."

D. Install building wire and cable according to Division 26 Section "Conductors and Cables."

E. Installation shall meet the following requirements:
1. Conceal cable and conduit, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway or conduit.
3. Install concealed cable using plenum rated cable.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. All wiring in lab areas shall be in conduit.
8. All unsupported risers shall be rigid steel conduit. Supported risers shall be EMT.

F. Rigid conduit shall be steel, hot dip galvanized, threaded with couplings, ¾ inch minimum size, manufactured in accordance with ANSI C-80-1. Electrical metallic tubing (EMT) with compression fittings or intermediate metallic conduit (IMC) may be used as conduit or raceway where permitted by the NEC.

G. Concealed control conduit and wiring shall be provided in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90 degree angles.

H. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.1.1.6 COMMUNICATION WIRING

A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

B. Do not install communication wiring in raceway and enclosures containing Class 1 wiring.

C. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

D. Cable bundling:
1. RS485 cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.
2. RS485 cabling run between terminal units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other class 2 low voltage cabling.
3. RS485 cabling run between floors shall be in a communication only conduit.
4. RS485 conduit run long distances between utility rooms or between buildings shall be in a communication only conduit.
5. Ethernet cabling shall be in a communication only conduit.
6. Ethernet and RS485 can be run together.
7. Fiber optics can be run with Ethernet and RS485 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.

E. RS485 Cabling
1. RS485 cabling shall be used for BACnet MS/TP networks.
2. RS485 shall use low capacitance, 20-24 gauge, twisted shielded pair.
3. The shields shall be tied together at each device.
4. The shield shall be grounded at one end only and capped at the other end.
5. Provide end of line (EOL) termination devices at each end of the RS485 network or subnetwork run, to match the impedance of the cable, 100 to 120ohm.

F. Ethernet Cabling
1. Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
2. CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
3. Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50 feet away.
4. When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.

G. Fiber-Optic Cabling
1. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
2. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3. All terminations shall to be made into a patch panel, designed for such use. Free air terminations with patch panels are prohibited.

H. All runs of communication wiring shall be unspliced length when that length is commercially available.

I. All communication wiring shall be labeled to indicate origination and destination data.

J. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.1.1.7 IDENTIFICATION

A. Control Equipment and Device labeling:
1. Labels and tags shall match the unique identifiers shown on the as-built drawings.
2. All Enclosures shall be labeled to match the as-built drawing by either control panel name or the names of the DDC controllers inside.
3. All sensors and actuators not in occupied areas shall be tagged.
4. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMS flow coefficient.
5. Duct static pressure taps shall be tagged at the location of the pressure tap.
6. Each device inside enclosures shall be tagged.
7. Terminal equipment need only have a tag for the unique terminal number, not for each device. Match the unique number on:
   a. First, the design drawings, or
   b. Second, the control as-builts, or
   c. Third, the DDC addressing scheme
8. Tags on the terminal units shall be displayed on the Operator Workstation Graphics.

B. Tags shall be mechanically printed on permanent adhesive backed labeling strips, 12 point height minimum.

C. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

D. Identification of Wires
1. Tag each wire with a common identifier on each end of the wire, such as in the control panel and at the device termination.
2. Tag each network wire with a common identifier on each end.
3. Tag each 120V power source with the panel and breaker number it is fed by.

3.1.1.8 FIELD QUALITY CONTROL AND OWNER TRAINING

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
3. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

B. Engage a factory-authorized service representative to perform startup service.

C. Replace damaged or malfunctioning controls and equipment.
1. Start, test, and adjust control systems.
2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

D. The BAS Contractor shall prepare and submit for approval a complete acceptance test procedure including submittal data relevant to point index, functions, sequence, interlocks, and associated parameters, and other pertinent information for the operating system. Prior to acceptance of the BAS by the Owner and Engineer, the BAS contractor shall completely test the BAS using the approved test procedure.

E. The BAS contractor shall fix punch list items within 30 days of acceptance.

F. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

G. During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware and accessories.

H. At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give 40 hours of onsite training on the operation of all BAS equipment. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:
1. Explanation of drawings and operator's maintenance manuals.
2. Walk-through of the job to locate all control components.
3. Operator workstation and peripherals.
4. DDC Controller and ASC operation/sequence.
5. Operator control functions including scheduling, alarming, and trending.
6. Explanation of adjustment, calibration and replacement procedures.

I. Additional 8-hours of training shall be given after the 30 day shakedown period.

J. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer's standard pricing such as transportation, meals, etc.

END OF 23 09 00

SECTION 232100 - EXCAVATION, TRENCHING, BACKFILLING, AND GRADING

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, 230500 General Mechanical Requirements, and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 The Contractor shall include all excavating, filling, grading, and related items required to complete their work as shown on the drawings and specified herein or as required to complete, connect and place all mechanical systems in satisfactory operation.

1.3 Unless otherwise shown or required, provide separate trenches for sewers, water lines and other underground raceways, with a minimum of 10 feet measured from outside diameter between pipes. In locations, such as close to buildings where separate trenches for sewers and water lines are impractical, lay the water pipe on a solid shelf at least 2'-0" above the top of the sewer and 2'-0" to the side.

1.4 Water lines crossing under sewer lines, or crossing less than 2 feet above sewer lines, must be concrete encased for a distance not less than 5 feet on either side of the point of crossover.

PART 2 – EARTHWORK CLASSIFICATION:

2.1 Without regard to the materials encountered, all excavation and materials excavated shall be unclassified. Materials to be excavated shall be unclassified, and shall include earth, rock, concrete or any other obstructions encountered in excavation and/or trenching to install underground utility pipes or other equipment.

2.2 Include all costs for rock removal, including mass rock and trench rock in the bids. No adjustment in the contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating. The Contractor shall be responsible for the removal of all materials encountered as required for the installation of the work.

2.3 It shall be distinctly understood that references to rock, earth, topsoil or any other excavated or non-excavated material or other material on the construction plans, cross section, contract documents, technical specification or provisions, whether in numbers, words, letters, lines or graphically shown, is solely for information for the Engineer and Owner. This information shall not be taken as an indication of the classification of the material to be excavated, bored or removed by any method, including drilling and blasting, or materials not removed. This information shall not be taken as to the quantity of either rock, earth, topsoil, or any other material involved, or the quality of the material such as hardness, wetness, workability or suitability of the material either during excavation and construction or as a material to be reused during construction.

2.4 The Contractor shall draw their own conclusions as to the surface and sub-surface conditions to be encountered during construction of this project. The Engineer and Owner does not give any guarantee or warranty as to the accuracy of the data shown and no claim will be considered for additional compensation when the materials encountered are not in accord with the information shown.

2.5 Refer to Specification Division EARTHWORK located in the Site Work portions of the Specifications and Civil Drawings for additional information. Also refer to the GEOTECHNICAL report included in the Front End of the Specifications.

PART 3 – BENCH MARKS AND MONUMENTS:

3.1 Maintain carefully all bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed.

PART 4 – EXCAVATION:

4.1 Excavate trenches of sufficient width for proper installation of the work. Excavate to 6" below the bottom of new pipes for installation of compacted grillage.

4.2 Sheet and brace trenches as necessary to protect workers and adjacent structures. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc., and current OSHA Standards. Do not remove sheeting until trench is backfilled sufficiently to protect pipe and prevent injurious caving. Where removal of sheeting and/or bracing is hazardous, leave in place. Cut off such sheeting not to be removed at least 3 feet below finished grade.

4.3 Rules and regulations governing the respective utilities shall be observed in executing all work under this Division. Active utilities discovered in the course of excavation shall be protected or relocated in accordance with written instructions from the Engineer. Inactive and abandoned utilities encountered in trenching operations shall be removed and abandoned with ends plugged or capped in accord with current codes and safe practice. If in doubt, contact Engineer.

4.4 Machine excavation shall not be allowed within ten (10) feet of existing electric lines, natural gas lines or other lines carrying combustible materials. Use only hand tools.

4.5 The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Engineer. Any damage to existing structures, exterior services, or rock intended for bearing, shall be corrected at the responsible Contractor's expense.

4.6 Perform final grading of trench bottoms by hand tools; carry machine excavation only to such depth that soil bearing for pipes and raceways will not be disturbed. Grade the bottom of trenches evenly to insure uniform bearing for all piping and raceways. Cut bell holes as necessary for joints and jointmaking. Except as hereinafter specified, bottom of trenches for bell and spigot pipe, flanged pipe, etc. shall be shaped to the lower quadrant of pipe with additional excavation for bell or flange. Piping installed where it rests on bell or flange and/or is supported with blocks or wedges will not be accepted.

4.7 Keep trenches free from water while construction therein is in progress. Under no circumstances lay pipe or appurtenances in water. Pump or bail water from bell holes to permit proper joining of pipe. Any dewatering from this Contractor's trenches which is required during construction, shall be included in this Contract.

4.8 In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, utility lines, large trees to remain, etc. The Contractors shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage or any other damage incurred in the course of excavation shall be at the responsible Contractor's expense.

4.9 Use surveyor's level to establish elevations and grades.

4.10 Machine excavation shall be held a sufficient distance from foundations and footings to insure no damage to same. Contractors shall accept full responsibility and pay for repairs and/or replacement of structural members, footings, etc.

4.11 The Contractor shall accept the site as it is and remove all trash, rubbish and material from the site prior to starting excavation work.

4.12 The Contractor shall provide and maintain barricades and temporary bridges around excavations as required for safety. Temporary bridges shall be provided where excavations cross paved areas and walks. The Contractor shall maintain these bridges in a safe and passable condition for all traffic until removal. Refer to OSHA Standards for such installations and comply with same in all details.

4.13 Pay particular attention to existing utilities and lines to avoid damage. The locations of existing lines which are indicated on the plans were taken unconfirmed from drawings prepared for previous construction and locations are approximate only. Also, certain water, gas, electric, storm and sanitary sewer lines and other underground appurtenances, active or abandoned, may not appear on the drawings. It shall be each Contractor's responsibility to ascertain the location of all lines and excavate with caution in their area.

4.14 Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at Contractor's expense.

PART 5 – BACKFILL, COMPACTION AND SURFACE REPAIR:

5.1 Backfilling for Mechanical Work shall include all trenches, manhole pits, storage tank pits, and/or any other earth and/or rock openings which are excavated under this Contract. Backfilling shall be carefully performed and the surface restored to its original level to receive new finish. Wherever trenches and earth openings have not been properly filled and/or settlement occurs, they shall be re-excavated, re-filled and properly compacted, smoothed off and finally made to conform to the level of the original ground surface.

5.2 All trenches shall be backfilled with 6" of manufactured sand or #8 crushed stone after finished excavation. Install the new pipe on the compacted fill material. Install tracer wire on pipe. Apply any special coatings to the pipe. Also perform all required pressure tests and check the grade of the pipe to ensure that it is correct and free of swags, bows or bends. Once coatings and testing are complete, backfill the pipe bed to 12" above the top of the pipe with specified compacted fill material. Backfill the remainder of the trench with earth (rock and debris free) tamped at 6" intervals. Water settling of backfill is permitted only as an aid to mechanical compacting.

5.3 Backfill and compact beneath areas to be seeded or sodded within six (6) inches of finished grade. The remaining six (6) inches shall be backfilled with clean top soil.

5.4 Backfill and compact beneath paved areas, walks, etc. shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill or unstable soil.

5.5 Wherever, in the opinion of the Engineer, the soil at or below the requisite pipe grade is unsuitable for supporting piping, special support shall be provided as directed by the Engineer.

5.6 Unsuitable material and surplus excavated material not required for backfill shall be removed from the site. The location of dump and length of haul shall be the affected Contractor's responsibility.

5.7 Provide and place any additional fill material from off the site as may be required for backfill. Fill obtained from off site shall be of kind and quality as specified for backfill and the source approved by the Engineer and shall be brought to the site by the Contractor requiring the fill.

5.8 If not specified or indicated elsewhere in the Contract Documents to be performed by Others, the Contractor shall lay new sod over their excavation work for existing disturbed grassy areas. Level, with adjacent surface, compact and water in accord with sound sodding practice.

5.9 Control soil compaction during construction providing minimum percentage of density specified for each area classification indicated as follows.

5.10 At a minimum, fill in grass areas shall be compacted to 90% Standard Proctor Density, ASTM D-698, at moisture content between 2 percent below to a 3 percent above the optimum moisture content or as specified in Specification Division EARTHWORK; whichever is most stringent.

5.11 At a minimum, fill in concrete or asphalt area shall compacted to 98% Standard Proctor Density, ASTM D-698, at moisture content between 2 percent below to a 3 percent above the optimum moisture content or as specified in Specification Division EARTHWORK; whichever is most stringent.

5.12 Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

5.13 Grading Outside Building Lines:

5.13.1 All materials used for backfill around structures shall be of a quality acceptable to the Engineer and shall be free from large or frozen lumps, large rocks, wood, and other extraneous material. All spaces excavated and not occupied by footings, foundations, walls or other permanent work shall be refilled with earth up to the surface of the surrounding ground, unless otherwise specified, with sufficient allowance for settlement.

5.13.2 In making the fills and terraces around the structures, the fill shall be placed in layers not exceeding 8 inches in depth and shall be kept smooth as the work progresses. Each layer of the fill shall be compacted. Sections of the fill immediately adjacent to buildings or structures shall be thoroughly compacted by means of mechanical tamping or hand tamping as may be required by the conditions encountered. All fills shall be placed so as to load structure symmetrically.

5.13.3 As set out hereinbefore, rough grading shall be held below finished grade and then the topsoil which has been stockpiled shall be evenly spread over the surface. The grading shall be brought to the levels as specified. Final dressing shall be accomplished by hand work or machine work, or a combination of these methods as may be necessary to produce a uniform and smooth finish to all parts of the regrade. The surface shall be free from clods greater than one inch in diameter. Excavated rock (1" and smaller) may be placed in the fills, but is shall be thoroughly covered. Rock placed in fills shall not be closer than 24 inches from finished grade. Refer to Specification Division EARTHWORK.

5.14 Maintenance Settling: Where settling is measurable or observable at excavated areas during Project Warranty Period, remove surface (pavement, concrete or any other surface or finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration.

5.15 Disposal of Excess Non-organic Soil and Rock: Any excess excavated waste material shall become the property of the Contractor and shall be disposed of by the Contractor off site at no additional cost to the Owner.

5.16 Unless otherwise directed by the Owner during construction, excess topsoil and subsoil suitable for fill shall be disposed of by the Contractor off site at no additional cost to the Owner.

PART 6 – MINIMUM DEPTHS OF BURY TO TOP OF PIPE:

6.1 In the absence of other indication, the following shall be the minimum depth of bury to top of pipe of exterior utility lines. Check drawings for variations.

6.1.1	Geothermal Lines	36 inches below final grade.
6.1.2	All Other Lines Not Listed	36 inches below final grade.

6.2 All exterior lines shall have a minimum earth cover of thirty six (36) inches to top of pipe, unless otherwise indicated.

END OF SECTION.

SECTION 23 2113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, and joining methods, for the following systems:
   1. Geothermal Water Piping
   2. Makeup Water piping.
   3. Cooling Coil Condensate Drain piping.

1.2 SUBMITTALS

A. Provide coordination drawings per Division 23 Section "General Mechanical Requirements".

1.3 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

D. Grooved mechanical piping systems shall be installed according to grooved manufacturer's installation instructions. All grooved piping products shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as grooved components.

PART 2 - PRODUCTS

2.1 PIPING

A. For piping 4 inches and smaller: Schedule 40 black steel pipe, furnace-butt welded, continuous welded (ASTM A53, Type F) or Drawn-Temper Copper Tubing (ASTM B 88, Type L).

B. For piping 5 inches and larger: Schedule 40 black steel pipe, electric-resistance welded (ASTM A53, Type E, Grade B).

2.2 PIPE FITTINGS

A. For Piping 2 Inches and Smaller
   1. Steel Pipe:
      a. Welded Wrought-Steel Fittings (ASTM A234).
      b. Cast-Iron Threaded Fittings, Class 125 (ASME B16.4).

c. Malleable-Iron Threaded Fittings, Class 150 (ASME B16.3).
d. Press-connect Fitting shall conform to material requirements of ASTM A420 or ASME B 16.3 and performance criteria of IAPMO PS117 or ICC LC 1002.

2. Copper:
   a. Welded or Soldered Wrought-Copper (ASME B16.22)
   b. Press-connect Fitting with EPDM sealing elements ASME B16.51, press-connect fittings shall have an unpressed fitting detection feature to detect unpressed fittings during the testing process.

B. For Piping Larger Than 2 Inches
1. Steel Pipe:
   a. Welded Wrought-Steel Fittings (ASTM A234)
   b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings, minimum Class 150 rating (ASME B16.5)
   c. Elbows shall be long radius having a centerline radius of 1.5 pipe diameters.
   d. Press-connect Fitting shall conform to material requirements of ASTM A420 or ASME B 16.3 and performance criteria of IAPMO PS117 or ICC LC 1002.
2. Copper:
   a. Soldered Wrought-Copper (ASME B16.22)
   b. Elbows shall be long radius having a centerline radius of 1.5 pipe diameters.
   c. Press-connect Fitting with EPDM sealing elements ASME B16.51, press-connect fittings shall have an unpressed fitting detection feature to detect unpressed fittings during the testing process.

C. Grooved Mechanical-Joint Fittings and Couplings
1. Contractors with minimum of 5 installed grooved mechanical-joint systems may use grooved mechanical joint fittings and couplings on roll grooved standard weight Schedule 40 piping 2 inches to 60 inches.
2. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic grooved mechanical-joint fittings and couplings. If another manufacturer is used with a manufacturer's torque requirement, the contractor shall create a log of the measured torque at every mechanical joint.
3. Grooved End Fittings: Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall, or fabricated from Std Wt Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633. (Fittings 14" and larger shall be supplied with Victaulic factory AGS grooved ends). For piping larger than 2 inches, elbows shall be long radius having a centerline radius of 1.5 pipe diameters.
4. Couplings 2" through 12": Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000.
   a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9 and NFPA 13.
      1) Victaulic Style 107N QuickVic®. Installation ready rigid coupling for direct stab installation, without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 Deg F to +250 Deg F.

b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source.
   1) Victaulic Style 177 QuickVic®. Installation ready flexible coupling for direct stab installation, without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 Deg F to +250 Deg F.

5. Couplings 14" through 60": Couplings shall consist of two ASTM A-536 ductile iron housing segments with wedge shaped AGS key profile and lead in chamfer.
   a. Rigid Type: Victaulic Style AGS W07. Coupling key designed to fill wedge shaped AGS groove. Gasket shall be Grade "E" EPDM with green color code designed for operating temperatures from -30 Deg F to +230 Deg F.
   b. Flexible Type: Victaulic Style AGS W77. Coupling key designed to fill wedge shaped AGS groove and allow for linear and angular movement, vibration attenuation, and stress relief. Gasket shall be Grade "E" EPDM with green color code designed for operating temperatures from -30 Deg F to +230 Deg F.
6. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness.
7. Victaulic prefabricated pump drop assemblies, which include check valves, butterfly valves, strainers, suction diffusers, flexible couplings (style 177 or W77), and grooved pipe, may be used in lieu of individual components. Victaulic Series 380, 381, 382.
8. Vic-Headers: Victaulic prefabricated factory-fabricated grooved end header [manifold] all-in-one assembly for fluid distribution. Header shall consist of an ASTM A53, Grade B, standard weight pipe spool with required outlet connections. Grooved ends roll grooved to Victaulic [OGS] [AGS] dimensions, with enamel coating or galvanized to project requirements.

2.3 INTERIOR GEOTHERMAL WATER PIPING OPTION:

A. Mains and branches – Piping shall be virgin polyethylene with a PE 3408 piping formulation and 345464C or greater cell classification. Pipe shall be SDR 15.5, minimum pressure rating of 110 psi at 73.4°F.

B. Individual Heat Pump Runouts - Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.

C. Special Note: Takeoffs and branch piping to individual coils or heat pumps shall not be connected to the top of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.

D. Transitions from HDPE to Copper – Factory Manufactured Transition required with brass or stainless steel threads. No metal threads shall be inserted into polyethylene piping, and no polyethylene threads shall be inserted into metal piping.

E. The only acceptable method for joining pipe is by a heat fusion process. Pipe shall be butt or socket fused in accordance with pipe manufacturer's procedures. All piping work shall be performed in accordance with Specification Section – 232300 Ground Loop Heat Pump Piping. Victaulic style 905/908 couplings may be utilized on above ground HDPE applications.

F. EXTERIOR GEOTHERMAL WATER PIPING: Refer to Specification Section – 232300 Ground Loop Heat Pump Piping.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals (Pipes 2 inches and less): ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals (Pipes greater than 2 inches): AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated without major deviations. Major deviations shall be approved by the A/E on Coordination Drawings prior to installation.

B. Coordinate the exact location of this work, with the work of other trades prior to fabrication or installation and verify all dimensions and elevations. Provide additional offsets and sections of piping as may be required to meet the applicable job conditions. Coordinate with and review all related drawings of all trades prior to start of work.

C. Main piping shall be run horizontal with no slope. Branch piping shall pitch down back to main piping, uniformly a minimum of one inch in 60 feet.

D. Provide trapped cooling coil condensation piping from outlets of drain pans of all cooling coils. Pitch all cooling coil condensation piping down a minimum of 1 inch in 30 feet in the direction of flow. Install insect screen at outdoor terminations.

E. Minimum pipe size shall be 3/4 inch unless noted otherwise.

F. Provide eccentric fittings and/or eccentric reducing couplings in all cases where air or water pockets would otherwise occur in the main due to reduction in pipe size. Eccentric fittings shall

keep the pipes flush on top for water piping and flush on the bottom for condensate or drain piping.

G. Do not run piping over or within 3 feet of electrical switchgear, panels, or similar equipment.

H. No piping shall pass through walls at an angle of other than 90 degrees.

I. No pipe, piping fittings, or coverings shall in any way extend partly into any plastered wall or ceiling.

J. Install piping concealed in walls, ceilings, webs of columns, or furring where possible, unless otherwise approved by the A/E and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

M. No piping shall be installed in a manner that will interfere with doorways, door and window operation, ventilation equipment, ductwork, lighting and outlets or other equipment, nor prevent proper vibration isolation or service of equipment or components.

N. Install all piping in locations and elevations such that coils, tubes, and filters can be removed and replaced without major piping removal.

O. Install piping to permit valve servicing.

P. Install piping to allow application of insulation.

Q. Install groups of pipes parallel to each other (where applicable).

R. If a hole is required after the structure is cast, its location and size shall be approved by the A/E and structural engineer. Core-drill the hole. Maintain the fire integrity of the structure.

S. All fittings shall be far enough away from plastered surfaces to allow space for installation of escutcheons. Escutcheons must not extend over any irregular parts of the walls, with all voids between piping materials and construction being properly filled in an approved manner. Provide nickel-plated steel escutcheons on all exposed pipes passing through walls, ceiling, floors, and partitions.

T. Provide unions or flanges of suitable temperature and pressure rating between all dissimilar metals including where copper tubing or components are connected to steel or cast iron piping or components. Unions on copper tubing shall be solder-type, copper-to-copper, up to and including 2-inch pipe size, and flanged 150-pound brass companion flanges for 2-1/2-inch pipe size and above.

U. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

V. Install flange or grooved coupling in piping, 2-1/2 inch and larger, at final connections to valves, apparatus, and equipment and elsewhere as indicated.

W. Install flexible connectors at inlet and discharge connections to pumps (except in-line pumps) and other vibration producing equipment. Option: Three flexible grooved couplings in lieu of each connector.

X. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe. The use of nipples welded directly into piping for branch take-offs will not be permitted.

Y. Install expansion loops, expansion joints, anchors, and pipe alignment guides as indicated on drawings.

Z. Install drains, consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

AA. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting. Install automatic air vents at high points of system piping in mechanical equipment rooms only.

3.2 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook".

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Align threads at point of assembly.
   2. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   3. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
   4. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Align flanges surfaces parallel with gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and

parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

I. Grooved Joints: Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. Install piping in accordance with latest installation instructions. Verify gasket is suitable for intended service. Factory trained representative (direct employee of grooved manufacturer) shall provide on-site training for contractor's field personnel.

J. Press-connect Joints: Pipe shall be cut with an approved pipe cutting tool. The pipe shall be cut square to permit proper joining with the fittings. Remove scale, slag, dirt and debris from inside and outside of pipe and fittings before assembly. The protective coating shall be removed from the outside of the pipe end and shall be wiped clean and dry. The burrs on the pipe shall be reamed with a deburring or reaming tool
   1. Perform the required two step pressure test:
      a. Initial test for unpressed fitting detection per manufacturer's installation instructions
      b. Full pressure test in accordance with code requirements

3.3 SLEEVES

A. Provide sleeves wherever pipes pass through building construction. Anchor all sleeves to building construction. Size sleeves to permit passage of insulation where insulation is required. Maintain the fire integrity of walls, floors, ceilings, and partitions.

B. Where pipes pass through foundation walls or footings, provide cast iron sleeve and caulk the space between sleeve and pipe with lead wool, watertight.

C. Install sleeves in floors perfectly plumb and sleeves in walls level. Center the pipe in the sleeve. Pack sleeves with fire rated materials, per shop drawings, approved submittals, and caulk in tight.

D. Set sleeves in walls, floor, and foundations during the construction.

E. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings and floors, maintain the fire-rated integrity.

3.4 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.
   4. Subject piping system to hydrostatic test pressure that is not less than 125 psi for a length of 6 hours. No pressure drop shall occur over this duration. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing.

C. Perform the following before operating the hydronic system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Set makeup pressure-reducing valves for required system pressure.
   4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
   5. Set temperature controls so all coils are calling for full flow.
   6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
   7. Verify lubrication of motors and bearings.

3.5 CLEANING

A. At completion of project, thoroughly flush each of the various HVAC hydronic circulating systems with a cleaning solution as recommended by the chemical supplier so as to remove any oil, rust, dirt, scale, or grease that may be present.

B. Utilize water treatment provider's instructions to clean system. Drain and rinse systems completely with clean water, and clean all screens and strainers.

C. After cleaning is complete, drain system and rinse with fresh water. The chemical supplier shall test and check drain water for pH level and condition.

D. Submit report to the Engineer on condition and finalized method of chemical treatment recommended by the chemical supplier and utilized for this project.

E. If drain water indicates an acid level, neutralize the system with an alkaline-type material as recommended by the chemical supplier and reflush entire system.

END OF SECTION 23 2113

SECTION 23 2116 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
1. Air separators.
2. Expansion tanks.
3. Safety relief valves.
4. Chemical feeders.
5. Thermometer wells and test gage connections.
6. Thermometers and pressure gages.
7. Combination pressure and temperature test stations.
8. Flexible Connectors
9. Air vents.
10. Strainers.
11. Unions.
12. Drains.

1.3 QUALITY ASSURANCE

A. All specialties to be ASME-labeled for ratings specified

B. Coils to bear ARI certification label

C. FCI Compliance: Test and rate "Y" type strainers in accordance with FCI 73-1 "Pressure Rating Standard for "Y" Type Strainers". Test and rate other type strainers in accordance with FCI 78-1 "Pressure Rating Standard for Pipeline Strainers Other than "Y" Type".

D. Grooved end specialties shall be of the same manufacturer as the adjoining couplings.

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data
1. Manufacturer's cut sheets and/or literature.
2. Performance data.

C. Grooved joint specialties shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series designation.

D. Samples: Not required for review.

E. Reference Submittals: Not required for review.

F. Contract Close-Out Information
   1. Operating and maintenance data.
   2. Warranty.

1.5 JOB CONDITIONS

A. Coordinate the exact application and location of this work with the work of other trades prior to installation within various piping systems. Verify all positions and elevations. Provide additional offsets and section of piping as required to position specialties for equipment clearance and accessibility and operational conditions.

B. Specialty manufacturer shall verify indicated figure or model numbers so that selection meets required description and conditions specified. Specified data shall take precedence over indicated figure or model number.

PART 2 - PRODUCTS

2.1 HYDRONIC AIR SEPARATORS

A. Hydronic air separators, unless otherwise noted on the Drawings, shall have flanged connections, shall be of the model size to accommodate the maximum system flow rate, and shall include a stainless steel system strainer. Provide manual globe-type air vent valve at high point and hose-end globe drain valve with chain, cap at low point of separator assembly, and piping increasers and reducers as required by inlet and outlet sizes. Separators shall be as made by Bell and Gossett, Armstrong, Wood, Taco, Spirotherm, **Grundfos (Addendum 2),** or approved equal.

2.2 BLADDER TYPE EXPANSION TANKS

A. Expansion tanks shall have a bladder that is suitable for the temperatures and type of solution served.

B. Initial and final air side charge shall be provided by the Contractor as directed by the Engineer.

C. Tanks shall be ASME stamped and rated for 125 psig system working pressure.

D. Tanks shall be as made by American Tube and Controls Company, Bell and Gossett, Taco, Wood, Armstrong, Patterson, **Grundfos (Addendum 2),** or approved equal, of the minimum size and capacity as noted or scheduled upon the Drawings.

2.3 SAFETY RELIEF VALVES, WATER

A. 2-1/2-Inch and Smaller: Farris, screwed, 10% over pressure.

B. 3-Inch and Larger: Farris, flanged, 10% over pressure.

C. Provide test levers.

D. Same capacity as system served.

E. Safety relief valve discharge piping shall spill over floor drains.

2.4 CHEMICAL FEEDERS

A. Provide type of treatment and chemical dosages in accordance with water analysis as recommended by the manufacturer of the treatment chemicals.

B. Chemical Feeders: Pot-type feeders constructed for operating pressure of 150 psi.
1. Capacity of Feeders: 3-gallon minimum.
2. Dome bottom bypass feeder, Model DB-5HD as manufactured by J.L. Wingert Co.

C. Water Treatment System Piping: Same type as system piping served.

2.5 THERMOMETER WELLS AND TEST GAGE CONNECTIONS

A. Temperature Sensing Walls
1. Brass or stainless steel.
2. Provide extension necks for insulated piping.
3. Provide test thermometer well adjacent to each point where a temperature-sensing device is required by control specifications and where piping schematics indicate thermometers.

2.6 THERMOMETERS

A. Weiss Model DVU35 digital self-powered, glass passivated thermistor, internal potentiometer with 6-inch stem. Thermometer wells to be brass or stainless steel, 2-inch extension in insulated piping. Provided threaded cap nut and cap. Or approved equal by Ashcroft or Trerice.

B. Thermometers Range Schedule

	Range (deg F)
Geothermal Water	0 – 150

2.7 PRESSURE GAGES

A. General
1. 4-1/2-inch dial, surface or flush-type, white face, black numerals, black pointers, bronze bourbon tubes and shatterproof glass.
2. Pressure Gage Range Schedule

	Range PSIG	Fig Interval PSIG	Inter Gradations PSIG
Geothermal Water	0 - 100	5	1

3. Waterlines: Ashcroft 1010 with 1092 gage cock and 1106 pulsation dampeners.

B. Pump Suction and Discharge Gages: Liquid filled, indicating range 0-100 psig.
1. Provide pressure snubbers for all pump pressure gauges.

2.8 COMBINATION PRESSURE AND TEMPERATURE TEST STATIONS

A. Pressure/Temperature Test Station, Combination
1. "Pete's Plug," to receive either a temperature or pressure probe 1/8-inch o.d.
2. Fitting: Solid brass, 1/4-inch MPT, with two valve cores of neoprene (maximum 200 deg F at 500 psi) or Nordel (maximum 275 deg F at 500 psi).

3. Provide long length (XL) at all locations with pipe insulation.
4. Provide with color-coded and marked cap with gasket, rated at 1000 psi at 140 deg F.
5. Provide at locations shown on equipment and piping schematic drawings.

B. Pressure Gage Adapter
1. 1/8-inch o.d. probe and 5-inch stem pocket testing thermometers each.
2. Provide two 25-125 deg F for geothermal water.

C. Pressure and Temperature Test Kit
1. 0-100 psi, 0-230 ft. w.g. gage with a No. 500 gage adapter thermometer.
2. 0-200 deg F pocket testing thermometer.
3. No. 500 gage adapter.
4. Protective carrying case.

2.9 FLEXIBLE CONNECTORS

A. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

B. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

C. Option: Flexible couplings may be used in lieu of flex connectors. Three couplings for each connector shall be placed in close proximity to the source of vibration. Victaulic S/177 flexible couplings. See Section 23 21 13.

2.10 AIR VENTS

A. Air Vents - Manual
1. Vent Valves: 1/4-inch 125 psi globe angle valve with XH nipple connecting to pipe.

B. Air Vents - Automatic
1. 150 psi rated, minimum.
2. Maximum working Pressure: 100 psig
3. Maximum Temperature: 220 deg F
4. Cast iron body with renewable valve and seat.
5. Synthetic rubber disc.
6. Armstrong AAE-750.

2.11 STRAINERS

A. General: Provide full line size strainers ahead of all water control valves, pressure regulating valves, suction side of pumps, and as indicated.

B. Hydronic Strainers
1. Y, T or basket-type, screwed, grooved or flanged.
2. 2 inches and smaller, brass body, screwed ends.
3. 2-1/2 inches and larger:

a. Cast iron body, flanged ends.
b. Ductile iron body, grooved ends.
4. Work Pressure, Non-Shock: 300 psig cwp.
5. Screens: Bronze, monel or stainless steel.
6. 2 inches and less: 3/64-inch perforations.
7. 2-1/2 inches and 3 inches: 1/16-inch perforations.
8. 4 inches and larger: 8-inch perforations.

2.12 UNIONS

A. Unions: Of same type, pressure rating and material as piping.

B. Flanges: Raised face type of same type, pressure rating and material as piping.

C. Unions in Copper Pipe
1. 2 Inches and Smaller: Use wrought copper solder joint copper to copper unions.
2. 2-1/2 Inches and Larger: Use brass flange unions.

D. Unions are not required in installations using grooved mechanical couplings. (The couplings shall serve as the unions.)

E. Dielectric Unions or Waterway Fittings: Standard products for prevention of galvanic corrosion.

2.13 DRAINS

A. Drains: 3/4-inch ball valve or as indicated on the Drawings.

B. Drains from Safety Valve
1. Provide at safety valves, where discharge is infrequent, or valves which have test levers.
2. Pipe to floor drain or janitors sink.

C. Drains on Copper Piping: Male iron pipe adapter and threaded brass cap except where valve drains are required.

D. Drains Pipe to Hose Bib: Provide over electrical equipment or other piping or equipment which makes access to drain valve difficult; pipe to accessible location with hose bib adapter.

E. Access Panels: Provide flush access panel where drains occur in concealed piping.

2.14 ACCEPTABLE MANUFACTURERS

A. Thermometers
1. Marsh Instrument Co.
2. Ashcroft.
3. Dwyer.
4. Marshalltown Instrument Inc.
5. Palmer Instruments.
6. Taylor Scientific Instruments.
7. Miljoco.
8. Weiss Instruments.

9. Weksler Instruments Corp.
10. Weston and Ernst.
11. Trerice.

B. Pressure Gages
1. Ashcroft.
2. Dwyer.
3. Marsh Instrument Co.
4. Miljoco.
5. US Gauge/Ametek.
6. Weiss Instruments.
7. Weksler Instruments Corp.
8. Weston and Ernst.
9. Trerice.

C. Pressure/Temperature Test Station (Pete's Plug)
1. Peterson Equipment Company, Inc.
2. Flow Design.
3. Sisco.

D. Flexible Connectors
1. Minnesota Flexible Corp.
2. Mason Industries.
3. Twin City Hose.
4. Pipe Solutions LTD.
5. Metraflex.
6. Flexicraft Industries.
7. Southeastern Hose Co.
8. Victaulic

E. Manual Air Vents
1. Crane.
2. Jenkins.
3. Johnston Corp.
4. OIC.
5. Powell.
6. Stockham.
7. Walworth.

F. Automatic Air Vents
1. Armstrong.
2. Spirax Sarco Inc.
3. Hoffman.
4. Bell & Gossett.
5. Thrush.
6. Taco.
7. Fisher.
8. Johnston Corp.

G. Hydronic Water Strainers
1. O.C. Keckley Co.

2. Armstrong.
3. Mueller Steam Specialty.
4. Tate Temco, Inc.
5. Victaulic.

PART 3 - EXECUTION

3.1 GENERAL

A. Install piping specialties according to manufacturer's instructions and as specified.

3.2 THERMOMETER WELLS AND TEST GAGE CONNECTIONS

A. Provide test thermometer well adjacent to each point where a temperature sensing device is required by control specifications and where piping schematics indicate thermometers.

3.3 THERMOMETERS

A. Where temperature control requires a temperature transmitter, a thermometer will not be required in same location unless specifically required in equipment specifications.

B. Where two or more pumps are headered, provide one thermometer in suction header and one in discharge header.

3.4 PRESSURE GAGES

A. Install filter-type pressure snubbers at pumps and chillers.

B. Install brass tee-handle cock and 1/4-inch hard tempered tubing from gage to pipe connection.

C. Install additional brass tee-handle cock at gage for panel mounted gage.

D. Calibrate and zero all gages at job site.

3.5 AIR VENTS

A. Air Vents - Manual
1. Vents shall prevent any part of system from being air-bound.
2. Pipe discharge of vent to a location where air and water may be collected in a bucket.
3. Provide at all trapped high points of cooling and heating piping systems, whether or not indicated.

B. Air Vents - Automatic
1. Provide shut-off valve ahead of vent.
2. Provide copper relief line from valve to drain or drip pan.
3. Provide at each high point in closed water systems and coil headers in air handling units.

3.6 STRAINERS

A. Y-Type Strainers: Same size as piping served.

B. Connections to suit piping.

C. Strainers 6 Inches and Larger: Provide 1-1/2-inch blow-down valve and pipe to floor drain.

D. Strainers 5 Inches and Less: Provide 3/4-inch blow-down valve with hose end connection.

E. Install strainers ahead of all automatic valves, regulating valves and pumps.

3.7 UNIONS

A. Install unions as directed by Fluid Controls Institute, Inc. (FCI).
   1. Make connections between couplings and flanged equipment with slip-on flanges.

B. Flanged Connections
   1. Where flanged valves are used at equipment connections, flange unions will not be required.
   2. Make connections to flanged valves and equipment using ANSI welding neck or slip on type welding flanges.
   3. Flanged cast iron ells may be used for connections between pumps, strainers, check valves, and other flanged equipment.

C. Unions are not required in installations using grooved mechanical couplings. (The couplings shall serve as the unions.)

D. Install dielectric unions or Waterway fittings at each piping joint and equipment connection between ferrous and non-ferrous materials

3.8 DRAINS

A. Provide drain valves to drain all piping systems and drain safety valves.
   1. For Draining Low Points of Piping: Minimum 6-inch nipple, with ball valve.
   2. On Piping 2-1/2 Inches and Larger: Ball valve with hose adapter.
   3. On Piping 2 Inches and Smaller: Ball valve.

B. Drains from Safety Valves
   1. Provide at safety valves, where discharge is infrequent, or valves which have test levers.
   2. Pipe to floor drain or janitors sink.

C. Drains on Copper Piping: Male iron pipe adapter and threaded brass cap, except where valve drains are required.

D. Drains Piped to Hose Bib: Provide over electrical equipment or other piping or equipment which makes access to drain valve difficult; pipe to accessible location with hose bib adapter.

E. Access Panels: Provide flush access panel where drains occur in concealed piping.

END OF SECTION 23 2116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. See Division 23 Section "General Mechanical Requirements".

1.2 DESCRIPTION

A. Work Includes
   1. Furnish all labor, materials, tools, equipment, and services for HVAC pumps, as indicated, in accordance with provisions of Contract Documents.
   2. Completely coordinate with work of all other trades.
   3. Although such work is not specifically indicated, provide all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Description of Systems
   1. In-line pumps.

1.3 QUALITY ASSURANCE

A. Standards
   1. Hydraulic Institute Standards
   2. Hydraulic Institute Engineering Data Handbook.

1.4 SUBMITTALS

A. Shop Drawings: Each equipment item specified.

B. Product Data
   1. Pump curves.
   2. Performance data.
   3. Manufacturer's cut sheets and literature.
   4. Materials of construction.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
   1. Operating and maintenance data.
   2. Parts list.
   3. Guarantee.

PART 2 - PRODUCTS

2.1 GENERAL

A. Acceptable Manufacturers
1. In-Line Pumps
a. Armstrong.
b. Aurora.
c. Grundfos.
d. Buffalo Forge.
e. Goulds.
f. ITT Bell & Gossett.
g. Peerless.
h. Taco, Inc.
i. Weil.
j. Weinman.
k. **Patterson. (Addendum 2)**
2. Flexible Pump Couplings
a. Dodge "Para-Flex".
b. Wood's "Sure-Flex".

B. Pumps and drives shall be made by same manufacturer.

2.2 IN-LINE PUMPS

A. In-line Pumps, Geothermal Water: Centrifugal, closed-coupled, single-stage, bronze fitted, vertical-mount.
1. Capacity: As scheduled.
2. Capable of being serviced without disturbing piping connections.
3. Pump Body: Cast iron with 125 psi ANSI drilled flanges.
a. Rated working pressure: 175 psi.
b. Provide with gauge ports.
4. Impeller: Non-ferrous material, enclosed-type.
a. Hydraulically and dynamically balanced.
b. Keyed to shaft and secured by locking capscrew.
5. Provide internally flushed mechanical seal with ceramic seal seat.
6. Non-ferrous shaft sleeve to cover wetted area under seal.
7. Motor: Open drip-proof enclosure with regreasable ball bearings.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all pumps according to manufacturer's recommendations and as specified.

END OF SECTION 23 2123

SECTION 232300 – GROUND-LOOP HEAT-PUMP PIPING

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, 230500 General Mechanical Requirements, and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

PART 2 – CONTRACTOR QUALIFICATIONS:

2.1 The loop installer/contractor shall have a current International Ground Source Heat Pump Association (IGSHPA) certification, having completed an IGSHPA training course in the fundamentals of design, installation, and operation of ground source systems, and having passed the IGSHPA certification examination.

2.2 Ground heat exchanger fabricators shall have completed a heat fusion school in which each participant has performed a heat fusion procedure under direct supervision of a IGSHPA Certified Heat Fusion Technician. The Fusion Technician shall be thoroughly familiar with heat fusion procedures, and have had formal training at a heat fusion school under direct supervision of an IGSHPA certified instructor.

2.3 Local and state laws, ordinances, and regulations as they pertain to buried pipe systems shall be strictly followed.

2.4 All Geothermal Contractors and any subcontractors bidding this project must have been a licensed company for a minimum of three (3) years to qualify to Bid this project. Individual employee experience does not supersede this requirement.

2.5 All geothermal subcontractors bidding the geothermal work must have completed one project of 100% this subcontract cost size and two projects of 70% this subcontract cost size in the Ohio region and is familiar with the drilling conditions, including the possibility of the Karst conditions.

PART 3 – SUBMITTALS:

3.1 Reference Specification Section SHOP DRAWINGS, MAINTENANCE MANUALS, AND PARTS LIST for additional requirements.

3.2 Submit the following items before construction activities:
- Manufacturer's specification sheets and installation instruction for each component of the system, showing manufacturer, pipe or tube weight, pressure rating, fitting type and joint type for each piping system.
- Manufacturer's data for geothermal headers, piping, valves, fittings, and components.
- Manufacturer's data for the grout mixture. Submit details on grouting procedures, methods and equipment.
- Written flushing, purging, pressure and flow testing plan. Include purge cart cut sheets.

3.3 Submit the following items after construction activities:
- Geothermal loop fluid test results.
- Grout testing results for 10% of vertical bores.
- Written results of flushing, purging, pressure and flow testing.
- Schedule dates for warranty period flushing, purging, etc.
- Survey/Record Drawings with dimensions from fixed benchmarks, depths and sizes.
- Written tracer wire test results.

- Submission of the completed items above is a condition of acceptance and closeout for the Project.

PART 4 – WARRANTY:

4.1 The entire ground loop system and backfill from a point 5'-0" inside the building shall be warranted for five years from date of substantial completion against any leakage or failure.

PART 5 – PIPING MATERIALS:

5.1 Acceptable pipe materials for the underground buried portion of the ground heat exchanger are polyethylene as specified in this Section. Piping shall be listed for closed-loop ground source geothermal application. The pipe and fitting of the buried system shall be warranted by the manufacturer for ground source heat pump service.

5.2 ACCEPTABLE MANUFACTURERS: Driscoplex 5300 Climate Guard, Centennial Plastics, Charter Plastics, Flying W Plastics, Lamson Vylon Pipe, PolyPipe, Inc.

5.3 Manufacturer shall supply a written warranty of 25 years or greater, specifying material replacement and labor allowance.

5.4 All pipe and heat fused materials shall be manufactured from a virgin polyethylene extrusion compound material in accordance with ASTM D-2513, Sections 4.1 and 4.2. Pipe shall be manufactured to outside diameters, wall thickness, and respective tolerances as specified in ASTM D-3035 and ASTM F-714 (3" and larger). Fittings shall be manufactured to diameters, wall thicknesses, and respective tolerances as specified in ASTM D-2683 for socket fittings and ASTM F-1055 for electrofusion fittings.

5.5 The pipe material shall maintain a 1600 psi hydrostatic design basis at 73.4 degrees F per ASTM D-2837, and shall be listed in PPI TR4 as a PE4710 piping formulation. The material shall be high density, polyethylene extrusion compound having a cell classification of PE445574 as specified in ASTM D-3350 except this material shall exhibit zero failures (F0) when tested for 192 or more hours under ASTM D-1693, condition C, as required in ASTM D-3350.

5.6 Pipe shall be manufactured in accordance with ASTM D-3035 and sized as follows:
- Pipe sizes 1¼" or less: DR 9 AND rated @ 250 psi.
- Pipe sizes 1 ½" – 2": DR 15.5
- Pipe sizes 3" and larger; DR 17

5.7 Sufficient information shall be permanently marked on the length of the pipe as defined by the appropriate ASTM pipe standard. Piping shall also have permanent factory length markings.

PART 6 – PIPE JOINING METHODS:

6.1 The only acceptable method for joining buried pipe systems is by a heat fusion process.

6.2 Polyethylene pipe shall be butt or socket fused in accordance with pipe manufacturer's procedures.

6.3 "U" bends fittings shall be used at bottom of the vertical bores. "U" bend fitting shall be manufactured by manufacturer of piping materials.

PART 7 – FLUSHING, PURGING, PRESSURE AND FLOW TESTING:

7.1 Refer to Specification Section 232500 HVAC Water Treatment, Cleaning, Filling, and Purging for additional information and coordination requirements.

7.2 Refer to Specification Section 230593 Mechanical Systems Testing, Adjusting, and Balancing for additional information and coordination requirements.

7.3 Include in the bid an additional, complete, piping network purge at substantial completion and at 3, 6, 9 and 12 months from substantial completion.

7.4 Successful flushing and purging is critical and shall be accomplished and documented. Notify Engineer prior to flushing and purging. Submit flushing and purging plan to engineer two (2) months prior to commencing this work.

7.5 Vertical loops shall be pressure tested before installation, and all horizontal components of the ground heat exchanger will be flushed, pressure and flow tested prior to backfilling. All fusion joints and loop lengths shall be checked to verify that no leaks have occurred due to fusion joining or shipping damage. Heat exchangers shall be tested hydrostatically at 150% of the pipe design rating or 300% of the system operating pressure (whichever is greater). No leaks shall occur within a 120 minute period.

7.6 The type of purging cart/equipment is critical to successful flushing and purging. The purge cart shall include a pump that minimally develops 500 gpm of flow at 130 feet of head pressure developed. It shall include a large purge return tank, interconnection piping, inlet/outlet pressure gauges, water flow readout display reversing valve and 4" flexible hose connection. Coordinate so that the header purge ports match purge cart couplings. The first circuit purged after hose connection shall be purged minimally one hour to remove extra air introduced from the hoses. Once the first circuit is purged, minimally purge other circuits for 30 minutes. Once all well circuits are purged, close all circuit valves and purge piping in building per Section – 232500 HVAC Water Treatment Cleaning, Filling and Purging.

7.7 Flow rates shall be compared to calculated values to assure that there is no blockage or kinking of any pipe. Submit written verification of compliance.

7.8 A minimum velocity of 3 ft/sec in each piping section must be maintained until all air is removed. The system shall also be forward and reversed to remove all debris. Purging of one wellfield row shall be witnessed by the Design Team, Owner, Mechanical Contractor, General Contractor and the Test and Balance Contractor. The Test and Balance Contractor shall confirm the minimum velocities are obtained during the purging process and shall also measure supply and return pressures. The Contractor shall provide P/T plugs as required by the Test and Balance Contractor. The Contractor shall provide all means and methods necessary to insure minimum velocities are obtained. After one test is confirmed, the other wellfield rows shall be tested utilizing the same procedure. The Test and Balance Contractor shall confirm all minimum circuit, flow rates are obtained for all wellfield piping.

7.9 Final purging of air from the entire building loop and wellfield loop shall be performed by the wellfield purging contractor so that air in the building will not be transferred with the wellfield. Coordinate with the Mechanical Contractor.

PART 8 – HORIZONTAL PIPING SYSTEMS:

8.1 Refer to Section 232100 Excavation, Trenching, Backfilling, and Grading for additional requirements.

8.2 Sharp bending of pipe around trench corners shall be prevented by using a shovel to round corners, or by installing an appropriate elbow fitting. Manufacturer's procedures shall be followed.

8.3 Backfilling procedure will include prevention of any sharp-edged rocks from coming into contact with the pipe by removal of the rocks before backfilling. Refer to details on the plans. Clods resulting from use of a backhoe shall be broken so as not to form air pockets around the pipe which will reduce heat conduction between the earth and the pipe. The flow of backfill soil must be controlled to prevent bridging and the formation of air pockets. Several slow passes with an angled backfill blade are required. Flooding is required to assure removal or air pockets. Minimum bury depth of piping shall be 48" to top of pipe.

8.4 Horizontal return bends must be backfilled by hand to properly support the pipes and prevent kinking.

8.5 Install continuous tracer wires on each wellfield circuit in and out of the building. Provide an additional 36" of coiled tracer wire on each end and attach in building at each circuit riser. Perform tracer wire testing for all tracer wires in conjunction with the Owner/Engineer – this is a condition of acceptance and closeout.

PART 9 – BORE HOLE AND GROUTING:

9.1 The Contractor shall accept the site as-is and is responsible for any and all required steel casings. If an area of voids is encountered, the Contractor shall either fill or re-drill wells in an approved area and extend piping to them. No night drilling will be allowed.

9.1.1 Geothermal and drilling contractors shall be familiar with the area, including the possibility of Karst conditions, and include in the project the appropriate means and methods, including drilling techniques (mud rotary, air rotary, or other drilling type) and methods as required, to provide the geothermal heat exchangers which utilize 1" DR9 HDPE piping.

9.2 The Contractor shall bore wells of a sufficient diameter to allow installation of the piping and U-bend and a 1-1/4" (minimum) HDPE tremie pipe for grout installation, but shall be no less than 6"-6 ½".

9.3 Bore holes shall be grouted to ensure good heat transfer. Local and state laws and regulations for grouting and backfilling shall be followed. See IGSHPA Grouting Procedures Manual for detailed grouting procedures.

9.4 Vertical bores shall be drilled to sufficient depths to ensure that the entire length of U-tube is inserted. This may require the bore to be drilled several feet deeper than the U-tube length.

9.5 All U-tube joints shall be visually inspected for integrity as specified by the pipe manufacturer (alignment of joints, proper bead roll-back) before insertion into the bore hole.

9.6 The bore hole annulus shall be completely grouted to ensure there are no air voids and to ensure there is consistent contact between the vertical piping and the bore hole formation. This will require the bore annulus to be filled with grout from the bottom to the top with a "tremie" tube.

9.7 The entire bore shall be grouted with a thermally enhanced grout mixture with a thermal conductivity of 1.00 Btu/hr-ft-°F. Grout shall be GeoPro Thermal Grout Lite 100 bentonite mixture or approved equal. Mixture shall be field mixed in strict accordance with manufacturer's recommendations. Grout mixture shall be mechanically pumped with a positive displacement pump into bore hole from bottom to top utilizing a tremie tube.

9.8 Through the course of the project, sample grout specimens shall be randomly (chosen by Engineer or Owner's Testing Agent) taken of the mixed grouting material by this Contractor for 10% of the vertical bores. An analysis shall be performed by the grout manufacturer to verify proper thermal performance and grout mixture. This Contractor shall submit these reports to the Owner, Architect and Engineer to verify compliance with the installation specifications.

9.9 Contractor shall calculate the required grout for the wells based on actual bore diameter and include a submittal for the quantity of grout provided (field measured) for each well and provide tabulation of gallons/cubic feet of grout utilized for each well.

PART 10 – ADDITIONAL INSTALLATION REQUIREMENTS:

10.1 Underground land survey of the entire geothermal wellfield system per 230500 General Mechanical Requirements. This shall include all horizontal piping, vertical bore locations and dimension from above grade fixed benchmarks. The underground survey shall be included in the closeout documentation.

10.2 Dust Control: The Contractor shall be responsible for and shall provide dust control. Dust shall not be allowed to leave the construction site boundaries, and furthermore, shall not be allowed to enter the building or accumulate on the building exterior. When needed to meet these requirements, the Contractor shall provide and operate a mechanical dust collection system to control dust at the source. Mechanical dust collection system shall consist of collection hood at the source ducted to a dust collector which separates dust from the airstream. Dust shall be collected into sealed containers for disposal by the Contractor. Water spraying may be used but shall not be considered a substitute for mechanical dust collection at the source when required.

10.3 Surface Water / Mud / Slurry Control: The Contractor shall be responsible for and shall provide control of all ground flowing fluids resulting from drilling operations. The Contractor shall erect silt fences or other structures as required to contain drill cuttings, mud, slurry, etc. within the construction site boundaries. In the event this requirement is not met, the Contractor shall provide all remediation measures as required by all authorities having jurisdiction over such events.

PART 11 – TEST BORES:

11.1 Test bores information and thermal conductivity testing information is provided on the drawings.

11.2 The Contractor may visit the site prior to bid and perform their own test boring if additional information is required. This shall be coordinated with the Owner.

END OF SECTION.

SECTION 232500 – HVAC WATER TREATMENT, CLEANING FILLING, AND PURGING

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, 230500 General Mechanical Requirements, and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 Review the Specification Section – 230500 General Mechanical Requirements. List and provide all documentations called for therein.

1.3 Through coordination with other Contractors, Vendors and Suppliers associated with this Project, this Contractor shall insure a complete, 100% functional, tested, inspected and approved systems. Claims for additional cost or change orders will immediately be rejected.

1.4 Provide a water treatment program for the closed loop piping systems. It is the Contractor's responsibility to contact the engineer 2 weeks in advance to any treatments performed on the systems. It is the Engineer's discretion whether or not this process should be monitored after notification.

1.5 A pre-installation meeting shall be held with the Owner, Architect, Engineer, General Contractor, Mechanical Contractor, Pipe Fitter Foreman, Geothermal Contractor and Chemical Treatment Contractor to discuss goals and expectations for cleaning, flushing, purging and chemical treatment.

1.6 Chemicals, equipment, testing services, and chemical application shall be supplied by a single water treatment company for undivided responsibility. The water treatment company shall be a recognized specialist, active in the field of commercial/industrial water treatment for at least 5 years. The water treatment company shall have regional water analysis laboratories, service department, and full time representatives located within the trading area of the job site or facility.

1.7 Furnish initial supply of the closed loop chemicals for each system. This contractor shall retest the systems after 3, 6 and 12 months to verify the proper dosage is in each system. Provide all closed loop chemicals and anti-freeze for the first year. Each system's water shall be tested for proper chemical parameters, clarity, and biological activity. If needed, provide chemical addition. Provide any laboratory and technical assistance required to achieve a successful program.

1.8 As a condition of acceptance and project closeout, a summary of water quality and treatment shall be provided in writing to the Owner and/or Engineer after the water treatment services have been completed. The closeout documentation shall include dates for warranty testing.

1.9 Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

1.10 Water Quality Minimum Performance Requirements:

- Closed hydronic systems shall maintain a pH value within 9 – 10.5.
- Total Aerobic Plate Count - Maintain a maximum value of 1000 organisms/ml.
- Total Anaerobic Plate Count - Maintain a maximum value of 100 organisms/ml.
- Nitrate Reducers - Maintain a maximum value of 100 organisms/ml.
- Sulfate reducers - Maintain a maximum value of 0 organisms/ml.

- Iron Bacteria - Maintain a maximum value of 0 organisms/ml.

PART 2 – CLEANING AND FLUSHING OF HYDRONIC PIPING:

2.1 This project consists of the following Hydronic Piping Loops:
- Geothermal Heat Pump Water System (Interior/Exterior)

2.2 There are several precautions which must be observed during its installation. This contractor is advised to read all of the manufacturer's instructions prior to commencing the installation. This cleaning and flushing of the systems must be accomplished.

2.3 All water circulating systems for the project shall be thoroughly cleaned before placing in operation to rid the system of dirt, piping compound, mill scale, oil and any and all other material foreign to the water. During construction, extreme care shall be exercised to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project shall have the open ends capped and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting or valve shall be visually examined and all dirt removed.

2.4 After each piping system is complete: (1) the Contractor shall first fill the piping loops and all runouts with clear water. The loop water shall be circulated for one hour with make-up water open and central drains open to accomplish initial flushing of the system. (2) After initial flushing, the individual terminal devices and coils may be connected permanently to the supply and return runouts conditions and then add trisodium phosphate in an aqueous solution to the system at the proportion of one pound per fifty gallons of water in the system. (4) After the system is filled with this solution, the system water shall be brought up to 95 degrees F temperature and allowed to circulate for two hours. (Equipment to be bypassed.) (5) The Chemical Treatment Contractor shall be given notice by the Contractor of scheduling this cleaning and, if the Engineer's representative deems it necessary, the operation shall be repeated. (6) After the system has been completely cleaned as specified herein, it shall be tested by litmus paper or other dependable method and shall be left on the slightly alkaline side (PH = 7.5 plus or minus). (7) If the system is found to be still on the acid side, the cleaning by use of Trisodium Phosphate shall be repeated. (8) After achieving required pH, close bypasses and circulate through equipment. (9) After the cleaning and flushing is complete, and approved, the Contractor shall provide the proper water treatment for the system.

PART 3 – CLOSED LOOP CHEMICAL TREATMENT:

3.1 Provide a 3/4" valved and capped port for injection of the closed loop chemicals into the system. Also, provide a bypass chemical pot feeder for each loop.

3.2 After the system is complete it shall be thoroughly cleaned before placing in operation to rid the system of dirt, biological contamination, piping compound, loose mill scale, oil, and any and all other material foreign to the water as previously specified.

3.3 Before chemical cleaning and sterilization of the entire system, the field and hydronic loop and mains shall be individually flushed and purged until free of dirt, debris, and air. During the flushing/purging and chemical cleaning processes the supply and return run-outs shall be temporarily placed in bypass operation. See SYSTEM FILLING & PURGING PLAN for additional information.

3.4 After chemical cleaning, the entire system shall be sterilized with a biocide added at recommended dosage to effectively kill any present microorganisms. Add glutaraldehyde to achieve 60 – 200 ppm of active ingredient or isothiazoline to achieve 10 – 13 ppm active. Do not

flush biocide from system. Corrosion inhibitors shall be installed in closed loop systems containing metal piping, fittings, accessories, etc.

3.5 A bacteria analysis shall be performed to ascertain biological cleanliness of system. If bacteria counts are above set parameters then sterilization process shall be repeated until bacteria counts are at or below acceptable levels. Microbiological limits are listed under "Water Quality Minimum Performance Requirements" elsewhere in this Specification Section.

3.6 Within 48 hours of the completion of the sterilization implement a water treatment program to passivate all metal surfaces.

PART 4 – SYSTEM FILLING & PURGING PLAN:

4.1 All piping circuits originate from mechanical pump room. System consists of heat pump mains and branch circuits plus well field circuits.

4.2 Temporarily connect the supply and return piping in the mechanical pump room at the purge valve location and close main line valve to isolate the building from the well field. Note that central filter pump can be used, after initial purging and for maintenance, as the purge pump (Well field in reverse direction). Refer to drawings for additional information.

4.3 The interior piping and the well field shall be purged individually. The building purging pump is capable of purging the interior loop purging after the system has been initially purged.

4.4 The system shall be filled under full city water pressure from the HVAC fill station located main mechanical room.

4.5 Obtain a minimum flow based on 2 to 3 fps in each circuit as indicated on the plans. Refer to plans for additional information.

4.6 Each circuit from the wellfield shall also be purged.

4.7 This procedure shall be carried out a minimum of three times to insure entrained air is removed.

END OF SECTION.

SECTION 23 3000 - DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. Description of Systems
1. Ductwork, fittings, and accessories.
2. Access doors.
3. Dampers.
4. Combination fire/smoke dampers.
5. Diffusers, registers and grilles.
6. Pressure relief doors.
7. Louver blank-off panels.
8. Duct leakage testing.

B. Work Installed But Not Furnished
1. Automatic dampers and operators. See Division 23 Section "Controls and Instrumentation".
2. Duct-mounted smoke detectors. See Division 26.

C. Definitions
1. Gage
a. Steel sheet and wire: U.S. Standard gage
b. Aluminum sheet: Browne & Sharpe Gage
c. Steel wire: Washburn and Moen Gage
2. Concealed Insulated Surfaces: Piping, ductwork and equipment in walls, partitions, floors, pipe chases, pipe shafts, duct shafts, sealed alleyways, and above suspended ceilings.
3. Exposed Insulated Surfaces: Piping, ductwork and equipment located in mechanical rooms, tunnels and rooms without suspended ceilings.

D. Drawings show tentative arrangement of partitions, diffusers and lights.
1. Owner reserves right to rearrange rooms, lights, and diffusers prior to actual installation to suit his needs.
2. Final location of diffusers, registers and grilles shall be from architectural reflected ceiling plans.

1.3 QUALITY ASSURANCE

A. Design and Installation Standards
1. ASHRAE Hand Book – HVAC Systems and Equipment, current chapter on duct construction.
2. ADC Standard 1062: GRD-84, Test Code for Grilles, Registers and Diffusers.
3. ADC Test Code FD 72-R1, Flexible Air Duct Test Code.

4. AMCA Standard 210, Test Code.
5. ASHRAE Standard 70, Method of Testing for Rating Fans for rating performance of Outlets and Inlets.
6. SMACNA HVAC Duct Construction Standard - Metal and Flexible, Third Edition, 2009. [NO EXCEPTIONS]
7. NFPA 90-A, Standard for the Installation of Air Conditioning and Ventilating Systems.
8. International Mechanical Code.
9. ASTM C1071: Microbial growth resistant coatings.

B. Fire and Smoke Rating Test Standards
1. ASTM E84, NFPA 255, and UL 723.

1.4 SUBMITTALS

A. Shop Drawings
1. Ductwork layout at 1/4-inch to 1-foot scale.
2. Indicate dimensions, elevations, clearances, etc.
3. Indicate all equipment, transitions, and fittings to scale.
4. Provide equipment connection details and ductwork support details.
5. Drawings shall be fully coordinated with the work of all other Trades.
6. Any interference that cannot be resolved between the various Trades shall be clearly identified on the Drawings.
7. Contractor shall not fabricate or install ductwork or equipment without approved Shop Drawings.

B. Product Data
1. All product items specified.
2. Manufacturer's literature and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Operating and maintenance data.
2. Test, Adjust and balance reports.
3. "As-Built" drawings.
4. Warranties.

1.5 JOB CONDITIONS

A. Coordinate the exact location of this work with the work of other trades prior to fabrication and installation. Verify all dimensions and elevations. Provide additional offsets and section of ductwork as required to meet job conditions. Coordinate with and review all related Drawings of all trades prior to start of work.

B. See requirements of Division 23 Section "General Mechanical Requirements".

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Ductwork: McGill Airflow LLC; Semco, Sheet Metal Products Co.; Tangent Air; Monroe Metal Manufacturing Co.; Spiral-Air; Regional Sheetmetal Manufacturing, LLC and Lindab USA.

B. Duct Sealer: Durkee-Atwood; Hardcast Inc.; McGill Airseal LLC; Foster Products Division; HB Fuller; and Ductmate.

C. Duct Sealing Tape: Durkee-Atwood; Hardcast Inc.; and McGill Airseal LLC.

D. Turning Vanes: Aero-Dyne; Airsan; Hart & Cooley; Titus; Vent Products Co.; and Ductmate.

E. Duct fittings: Buckley, Flexmaster USA, Ins, McGill Air Flow LLC, ACME Mfg.

F. Flexible Fan Connections: Base: Duro-Dyne; Elgin; Ventfabrics; and Ductmate.

G. Flexible Duct: Acme Manufacturing Co.; Flexmaster USA, Inc.; Clevepak Corp.; Clevaflex Division; General Flex Corp.; Flexible Technologies, Automation Industries, Inc.; Flexible Systems Group.

H. Access Doors: Advanced Air, Inc.; Air Balance Inc.; Air Dynamics, Inc.; Greenheck; Prefco Products, Inc.; Ruskin; McGill Airflow LLC; Ventfabrics; Zurn Industries, Inc.; and Ductmate.

I. Manual Dampers: Air Balance, Inc.; Greenheck; Krueger; Pottorff; Prefco Products Inc.; Ruskin Manufacturing Co.; McGill Airflow LLC and Safe-Air Inc.

J. Backdraft Dampers: Air Balance, Inc.; Greenheck; Cesco; Pottorff; Prefco Products Inc.; Ruskin Manufacturing Co.; and Safe-Air Inc.

K. Diffusers, Registers, and Grilles: Anemostat; Krueger; Titus; and Price.

L. Pressure Relief Doors: Ruskin, Green Heck, Pottorff, KEES, AJ Manufacturing, Inc.

2.2 MATERIALS—GENERAL

A. Sheet Metal
1. Galvanized Steel: ASTM A93, A924, A653, F.S. QQ-I-716

B. Duct Sealer
1. NFPA rating of "Non-Combustible."
2. Flame Spread Rating: 25 or lower, in dry condition.
3. Smoke Developed Rating: 50 or lower, in dry condition.
4. Resistant to water and water vapors.
5. Pressure Rupture Rating: 16-in. water gauge, minimum.
6. Durkee-Atwood, Permatite Class I; Hardcast 601; or United McGill, Uni-Grip Duct Sealer.

C. Flexible Ducts
1. UL 181, 191
2. NFPA 90A and 90B

D. Solder: ASTM B23, Grade 50B or F.S. QQ-S-571, Composition Sn50.

E. Duct Sealing Tape
1. NFPA rating of "Non-Combustible."
2. Flame Spread Rating: 25 or lower, in dry condition.
3. Smoke Developed Rating: 50 or lower, in dry condition.
4. Adhesive: Specifically compounded for adhesion to galvanize and stainless steel.
5. Tape to be UL listed.

F. RTV Foam: UL-listed room temperature vulcanized silicone rubber foam.

G. Acoustical Duct Liner (Transfer air only)
1. Knauf, Certain Teed Corp., Owens-Corning, Manville or Manson.

2.3 DUCTWORK, FITTINGS, AND ACCESSORIES

A. Ductwork - General
1. Constructed of galvanized steel sheet.
a. Maintain full areas and suitable shapes at all points.
b. Shapes may be changed to fit unusual space conditions.
c. Provide all necessary transitions and offsets to complete systems.
2. Each duct system shall be constructed for the specific external static pressures shown on the Contract Drawings.

B. Ductwork, under 4 in wg (water gauge), Sheet Metal
1. Ductwork includes but is not limited to:
a. All supply ductwork downstream of terminal boxes.
b. Return, exhaust, relief and outdoor air ductwork systems operating under 4 in wg (positive or negative).
c. Supply ductwork systems connected to single zone equipment (air handlers, fan coils, heat pumps, furnaces, etc.) operating under 4 in wg.
2. Construct in accord with SMACNA HVAC Duct Construction Standard as follows:
a. Rectangular duct: Table 2-5 or 2-19, positive or negative.
b. Round duct: 10 in wg static pressure Table 3-5, positive or Table 3-13 negative.
c. Round ducts shall be spiral seam.
3. For all ducts with longest side 24 inches and over: Construct using the Ductmate, Nexus, Quicduc, SMACNA T-24 flange, or Pyramid-Lok duct connection systems.
a. Seal flanged ends with pressure-sensitive, high-density, closed-cell neoprene or polyurethane tape gasket, "Tremco 440", or butyl gasket.
b. For smaller duct sizes (longest side 23 inches or less): Above systems are optional.
4. Seal all ducts based on external static pressures. For external static pressures below 1.5 in wg seal to meet SMACNA Seal Class B for 2 in wg as a minimum. For external static pressures below 4 in wg seal to meet SMACNA Seal Class A for 10 in wg as a minimum.
5. Runouts to Supply Diffusers, Registers and Grilles: May use flexible ducts.
a. Exception: Flexible ducts may not pass through smoke or fire-rated walls, floors, or ceilings.
b. Maximum flexible duct length: 5 ft.
c. Minimum turning radius: As recommended by manufacturer.

C. Ductwork, 4-inch wg and Over
1. Ductwork includes:

a. All supply ductwork from air handling unit discharge to connection with terminal boxes.
b. Supply, return, exhaust, relief, and outdoor air ductwork systems operating 4 in wg and over (positive or negative).

2. Construct in accordance with SMACNA HVAC Duct Construction Standard as follows:
   a. Rectangular duct: Table 2-7 or 2-21, 10 in wg static pressure, positive or negative.
   b. Round duct: Table 3-5 10 in wg positive static pressure. Table 3-13, 10 in wg negative static pressure.
   c. Flat oval duct: Table 3-15, 10 in wg static pressure.
   d. Round and flat oval ducts to be spiral lockseam constructed.
3. Runouts to Air Terminal Units: Rigid or flexible ductwork.
   a. Exception: Flexible ducts may not pass through smoke or fire-rated walls, floors, or ceilings.
   b. Maximum flexible duct length: 3 feet.
   c. Minimum turning radius: As recommended by manufacturer.
4. Seal all ducts to seal Class A requirements.

D. Aluminum Ductwork
1. Use aluminum ductwork for systems as noted on drawings.
2. Construct in accordance with SMACNA HVAC Duct Construction Standard as follows:
   a. Type 3003-H14, conforming to ASTM B-209.
   b. Use Table 2-50 to convert galvanized steel gauges required in paragraphs above, to comparable aluminum thicknesses.
   c. Use Table 2-51 and Table 2-52 and notes for how to adapt the steel duct reinforcement required in paragraphs above, to comparable aluminum reinforcement.
3. Duct joints shall be all-soldered construction.
4. Provide only fasteners, hangers, turning vanes, access doors, taps, fittings, dampers, insulation, supports, reinforcing, and accessories that are fully compatible with aluminum.

E. Duct Hangers and Supports
1. In accordance with the following:
   a. Ductwork (Sheet Metal): SMACNA HVAC Duct Construction Standard, Chapter 5.

F. Duct Fitting and Joints under 4-Inch wg
1. Radius Elbows Without Vanes: Radius ratio (R/W) of 1.5 and greater.
   a. Radius ratio (R/W) less than 1.5 are not allowed.
2. Where square throat elbows are indicated or required, provide with turning vanes.
3. Connections to Diffusers, Grilles and Registers: Fitted securely to necks or collars provided behind diffuser, grille, or register face area.
4. Branch Connections
   a. Round: Factory-built bellmouth-type with locking quadrant damper.
   b. Rectangular: 45-degree entry type or radius elbow.
5. Provide all necessary transition pieces and duct collars to make connections to ductwork from neck sizes scheduled or shown on Drawings.
6. Where building walls, floor and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted to building structure.

G. Duct Fittings and Joints on Systems 4 in-Inch wg and Over

1. Elbows 3- through 12-Inch Diameter: Die-stamped, for minimum air friction loss, with continuous corrosion-resistant welds.
2. Elbows over 12 Inch Diameter: Welded segment-type or standing seam, not less than 5 pieces for 90-degree elbows, and not less than 3 pieces for 45-degree elbows, using corrosion-resistant welds.
3. Tees: "Low loss, short cone-type," unless specifically detailed otherwise for space limitations.
4. "Y"s 45-degree type; 60-degree type may be used if space conditions dictate.
5. Install "Y"s where indicated.
6. Where tees are indicated, "Y"s may be substituted if space is available.
7. "Y"s: Straight-sided-type (no cone).
8. Take-Offs from Air Handling Unit Plenums: Bellmouth fittings.
9. "Y" take-offs from horizontal ceiling mounted ducts to serve boxes: May be straight-sided, shop-fabricated-type by accurately cutting and welding "Y"s into spiral ducts without use of fittings.

H. Turning Vanes
1. For square-throat elbows.
2. Velocities up to 2500 fpm: Single-vane, runner Type 2, with 3/4-inch trailing edge, 2-inch vane radius, and 1-1/2-inch vane spacing, minimum 24-ga.
   a. For widths over 36 inches install vanes in 2 or more sections or use tie rods to limit unbraced vane length.
3. Where inlet and outlet dimensions of elbows are not equal, set 2 or more sections at 45-degree angle to give optimum turning as detailed on sheet metal drawings.

I. Partitions and Blank-Off Plates
1. Where used as part of an air handling unit, construct of 14-ga sheet metal with 1-1/2-inch standing seams.
2. Partitions 8 feet long or less: Use 1-1/2 x 1/4-inch angles spaced 2 feet on centers for additional bracing.
3. Partitions over 8 feet long: Use 2 x 1/4-inch angles.

J. Flexible Fan Connections
1. Material: Minimum 30-ounce Neoprene double-coated closely woven glass fabric flexible connections.
2. Fasten fabric to sheet metal duct work and to fan collar extension with 3/16-inch rivets spaced not more than 5 inch on center.
3. Locate in inlet and outlet of all fans, as close to fan as possible.
4. Provide at all ducts crossing building expansion joints and where indicated on drawings.
5. Connections shall not be under tension.
6. Isolate duct system from all equipment by at least 1 inch.

K. Flexible Ducts, Preinsulated
1. Under 4 inch wg Construction
   a. Spiral wire or band, reinforced fabric liner or flexible aluminum or galvanized steel duct.
   b. Nominal 1 inch x 3/4 lb/cf fiberglass insulation covered with vinyl, polyethylene or reinforced metallized vapor barrier.
2. 4 inch wg and Over Construction
   a. Spiral wire or band, reinforced fabric liner or 2-ply flexible aluminum or hot-dip galvanized duct.

b. Nominal 1inch x 3/4 lb/cf fiberglass insulation covered with vinyl, polyethylene or reinforced metallized vapor barrier.

3. Rated Working Pressure
   a. Under 4 in wg duct: 5 inches positive or negative.
   b. 4 inch wg and over duct: 10 inches positive.
4. Fire-resistant, self-extinguishing, UL Standard 181, Class 1, with flame spread of 25 or less and smoke development not to exceed 50.
5. R value – 6.0 unconditioned spaces, 4.2 conditioned spaces.
6. Under 4 inch wg Connections
   a. Secure non-metallic duct to collar or sleeve with nylon draw band.
   b. Secure metallic duct (under 12 inches in diameter) to collar with minimum three #8 sheet metal screws equally spaced around the duct's circumference. For ducts 12 inches in diameter and over, use minimum five #8 sheet metal screws.
7. 4 inch wg and over Connections
   a. Secure duct to collar or sleeve with duct sealer and 1/2-inch aluminum or galvanized steel bands or clamps.
   b. Secure insulation jacket with 2 wraps of duct tape.
8. Insulation and vapor barrier on factory-fabricated ducts shall be fitted over the core connection and shall also be secured with a draw band.
9. Duct Sealer: E Moore Co., Tuff-Bond No. 12; Benjamin Foster No. 30-02, or McGill Airseal.
10. Turn Radius: Not less than R/D equal to 1.0.
11. Provide flexible duct supports in accord with Figure 3-10 and 3-11, SMACNA HVAC Duct Construction Standards.
12. FLEXIBLE DUCTS SHALL NOT BE USED FOR RETURN OR EXHAUST.

L. Access Doors
1. Provide at all fire, smoke, or duct-mounted dampers and where indicated.
2. Doors shall close with air pressure, and shall have latches and hinges.
3. Provide doors with 2-inch extension necks to clear insulation where applicable.
4. Install all doors to permit easy visual inspection of fire or smoke dampers.
5. Hardware: Ventlok, or equal, as follows:
   a. Doors up to 12-inch maximum, in any direction: One No. 100.
   b. Doors up to 18 inch long: Two No. 140 or No. 205.
   c. Doors up to 24 inch long: Two No. 260.
   d. Doors over 24 inch long: Two or more No. 310.
   e. Door handles: Ventlok 220
6. Provide gasket seal on all access doors.

2.4 DAMPERS

A. Dampers - General
1. Sizes and Types: As indicated.
2. Locate where indicated.
3. Factory-built and -assembled dampers.

B. Dampers, Automatic-Control-Type
1. Furnished in Division 23 Section "Controls and Instrumentation".
2. Install as specified in this Section.

C. Dampers, Manual (Rectangular and Square)

1. Opposed-blade-type, fitted with shank bolts, marked for direction (open/closed).
2. Provide for double-socket wrenches to fit square shank and locking hex nut.
3. Construction: Heavy minimum 12-gauge galvanized steel frames, flat or angle iron, with blades of 16-ga galvanized steel, equipped with brass pin running on stainless steel pivot for vertical axis.

D. Damper, Manual (Round)
1. Butterfly-type with circular blade mounted to shaft.
2. Frame: Minimum 14-ga galvanized steel channel.
3. Blade: Minimum 16-ga galvanized steel.
4. Axle: 1/2-inch diameter.
5. Bearings: Self-lubricating nylon or stainless steel sleeve.

E. Dampers, Backdraft, under 4 inch wg
1. Counterbalanced, gravity-operated.
2. Fabricate of aluminum.
3. Blades: Provided with common linkage rod and felt seals.

2.5 DIFFUSERS, REGISTERS, AND GRILLES

A. Diffusers, Ceiling
1. Square-type or slot-type as indicated.
2. Size, Type, and Manufacturer: As scheduled.
3. Finish: Factory-applied, baked or electrocoated enamel; color as selected by A/E or as indicated.
4. Sponge rubber gasketed for ceiling diffusers and supply registers.
5. Provide all necessary screws, duct collars, transitions and air pattern deflectors.
6. Paint interior of perforated supply and return diffusers flat black. Exterior surfaces to match ceiling color, of factory enamel finish.
7. Use nominal 24-x 24-inch panel style diffusers in areas with lay in ceilings.
8. For hard ceilings, use 12- x 12-inch face diffusers with overlap style mounting for 6-inch diameter neck sizes; and 24- x 24-inch face for neck sizes 8 inches and larger.
9. Use circular diffusers in areas where ductwork is exposed only where indicated.
10. For all Supply Air devices, provide with molded insulation blanket/insulated backpan unless noted otherwise.
11. Provide opposed-blade dampers where scheduled on the Drawings.
12. Provide easily removed inner core with a positive lock.

B. Air Grilles and Registers
1. Size, Type, and Manufacturer: As scheduled.
2. Finish: Factory-applied, baked or electrocoated enamel; color as selected by A/E or as indicated.
3. Sponge rubber gasketed for ceiling and wall supply units.
4. Provide all necessary screws, duct collars, and transitions.
5. Provide opposed blade dampers with supply air grilles and registers where scheduled on the Drawings.

C. Diffusers and Grilles, Linear
1. Size, Type, and Manufacturer: As scheduled
2. Adjustable pattern, extruded aluminum or steel.
3. Fixed pattern, extruded aluminum, airline grille with 0-degree deflection, and damper.

4. Fixed pattern, extruded aluminum, airline grille with 15-degree deflection, and damper.
5. Contractor to coordinate the use of manufacturer provided or field-fabricated insulated plenum.

2.6 PRESSURE RELIEF DOORS

A. Provide pressure relief doors to relieve pressure and prevent structural damage to ductwork or plenums in the event excessive pressure within the air distribution systems should occur. Provide in the supply and return air paths of air handling units.

B. Doors to open at 8 inches wg static on supply systems and -4 inches wg on return systems.

C. Doors to automatically close and reset when the static pressure is reduced to less than 4 inches wg on supply systems and -2 inches wg on return systems

D. Doors to be installed to open outwardly to relieve positive pressure build-up or to open inwardly to prevent damage due to negative pressure.

E. Construction
1. 12-ga galvanized steel frame and door.
2. Polyurethane foam seal around door perimeter.
3. Negator springs for door closure upon loss of over-pressurization.
4. 18 x 18 inch size.

F. Ruskin PRD18 pressure relief door.

G. Install vertically and level for proper operation.

2.7 LOUVER BLANK-OFF PANELS

A. Provide blank-off panels behind inactive louver sections.
1. Double-wall construction with minimum 22-ga galvanized sheet metal and 2-inch-thick rigid insulation.
2. Paint side facing louver flat black.

2.8 DUCT LEAKAGE TESTING

A. For ducts constructed for 4-incg wg and above:

B. Use procedures listed in the "HVAC Air Duct Leakage Test Manual".

C. Provide a report to the Engineer of the findings of the duct leakage test.

D. Coordinate testing with the Commissioning Agent and Construction Manager.

PART 3 - EXECUTION

3.1 GENERAL

A. Form and erect ductwork to avoid pipes, lighting fixtures, joists, beams, etc., and to maintain head room and clearances required for the project, or as noted. Coordinate locations with work

of all Trade Contractors. Verify all dimensions and elevations. Special attention is again directed to the pre-construction layout drawing and coordination requirements of this section.

B. Provide all offsets and modifications to the duct systems required because of interferences encountered. It is this Contractor's responsibility to avoid this as much as possible by coordinating his work with the work of the other Contractors. If modifications are necessary, this Contractor shall perform all such modifications and offsets in an approved manner as required for this work, at no additional cost.

C. Volume dampers or splitter dampers shall operate without rubbing side of ducts or binding. Blades shall be tight on shaft. If dampers are loose and noisy, system will be rejected and damper shall be replaced.

D. Only one damper regulator will be allowed per multi-blade damper. All multi-blade dampers shall be provided with Vent Fabrics, Inc. parallel blade and opposed blade hardware. Dampers shall be set in a 3/8-inch x 2-inch steel frame.

E. If, because of obstructions, damper regulation is not possible with the above hardware, regulation shall be accomplished with right angle gear assemblies. Dampers in concealed ductwork shall be operable at concealed regulators.

F. Provide concealed regulators for volume dampers in concealed ductwork.

G. Paint inside surface of ductwork for a distance of two feet directly behind air devices, with flat black where sheet metal is visible.

3.2 INSTALLATION OF DUCTWORK

A. Install ductwork in accordance with arrangements and sizes indicated on the Drawings; construct of the best grade of galvanized steel unless otherwise specified. Include all necessary elbows or square turns with turning vanes of the double-wall galvanized steel air-foil-type, deflectors, dampers, damper quadrants, hangers, etc., and erect in a thorough and workmanlike manner. Rectangular ducts of 14-inch size dimensions and under, and round and oval ducts, shall have radius turns, with inside radius equal to or greater than the dimension of duct in direction of turn, in lieu of turning vanes.

B. Conceal all ductwork in finished spaces unless indicated otherwise.

C. All ductwork exposed to view shall be supplied and installed with paint grip galvanizing with final painting of same by the painting Trade Contractor. Painting shall not be a part of this Contractor's work. Do not paint ceiling-hung ductwork in electrical equipment rooms or sensitive production areas and switchrooms.

D. Form radius elbows with a 1-1/2 ratio of centerline radius of duct dimension in the direction of the turn wherever possible.

E. Do not install ductwork in or allow to enter or pass through electrical rooms, elevator machine rooms, or spaces housing switchboards, panelboards or distribution boards, except ductwork that serves electrical rooms, elevator machine rooms, or spaces.

F. Exercise special care to provide tight-fitting well-fabricated, well-braced ductwork systems.

G. Field assembly rectangular, round or flat oval ductwork as follows:
   1. Use caulking-grade joint sealer applied slip joints, or:
   2. Use slip joints, couplings, etc., sealed with "shrink-fit" plastic bands, with thermal setting adhesives pre-applied to plastic bands, or:
   3. Use slip joints, couplings, etc., sealed with pressure-sensitive tape.
   4. Isolate dissimilar metals with elastomeric sealant tape or fiber gaskets, and gaskets and washers for bolts.

H. In ducts 4-inch wg and over ductwork, do not use 2-piece mitered 90-degree elbows with or without vanes unless approved by Engineer.

I. Make all duct connections from hoods, openings, fans, and other devices.

3.3 CLEANING

A. At completion of work and prior to final acceptance, clean all work installed under this Section.

3.4 EQUIPMENT DEMONSTRATION

A. Prior to final acceptance, inspect, test, and operate satisfactorily, in presence of Engineer and representative of the Owner, operation of each piece of equipment and its accessories.

B. If inspection or test shows defects, replace defective work or material.

C. Repeat inspections and tests until defects are eliminated.

END OF SECTION 23 3000

SECTION 233400 – HVAC FANS

PART 1 - GENERAL

PRODUCT DATA SHEET 0 - REFERENCE

1.1 All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

PRODUCT DATA SHEET 1 - DESCRIPTION

1.1 DESCRIPTION OF SYSTEMS
1. Air destratification fans: Airius model: 25-EC

1.2 ABBREVIATIONS
1. AMCA: Air Moving and Conditioning Association.
2. ADC: Air Diffusion Council.
3. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.

PRODUCT DATA SHEET 2 - QUALITY ASSURANCE STANDARDS
1. ADC Standard 1062R2, Air Diffusing Equipment Test Code.
2. AMCA Standard 210, Test Code for Air Moving Devices.
3. ASHRAE Standard 70, Method of Testing and Rating the Air Flow Performance of Outlets and Inlets.
4. NFPA 90-A, Standard for the Installation of Air Conditioning and Ventilating Systems.
5. UL listed as "Power Ventilator for Smoke Control Systems" (where applicable).

PRODUCT DATA SHEET 3 - SUBMITTALS

1.1 All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section "Submittals".

1.2 Shop Drawings: All equipment items specified, including fan curves.

1.3 Product Data
1. Dimensional Drawing.
2. Performance data.
3. Fan curves for specific operation, with flow, static pressure, and horsepower.
4. Sound data

1.4 Contract Close-Out Information
1. Operating and maintenance data.
2. Owner instruction report.

1.5 ACCEPTABLE MANUFACTURERS
1. Airius, Zoofans, Continental Fan

PART 2 - PRODUCTS

PRODUCT DATA SHEET 0 - GENERAL

2.1 Fans - General
1. Performance ratings: Based on laboratory tests conducted in accordance with latest edition of the ASHRAE/AMCA Standard Test Codes. All fans to be AMCA labeled.
2. Ratings: As indicated.
3. Arrangement and drive: As indicated.
4. Provide removable belt guard.
5. Drive sheaves
   a. Cast iron, split tapered bushings dynamically balanced at factory.
   b. Provide wide-range variable-speed adjustable sheaves to be used for balancing systems.
   c. Provide final fixed pitch drive sheaves for proper RPM determined during balancing process.
6. Finish: Applied or as indicated on Drawings.

PRODUCT DATA SHEET 1 - AIR PEAR DESTRATIFICATION FANS

2.1 Performance: Coordinated design of housing, stator and motor shall provide columnar laminar airflow to produce a minimum of 100 fpm at center of column at grade level.

2.2 Housing: The fan housing shall be made of PC/ABS resin, rated 5VA for flame resistance.
1. Housing Color:
   a. PMS Cool Gray 2C (off white)

2.3 Safety Cable: Models 10 through 45 are supplied with tabs in each corner of faceplate to affix safety wire to building structure.

2.4 Motor Mounting: Enclosed in housing, above stator.

2.5 Stator: The fan shall be equipped with a patented multiple-vane stator coordinated with fan design for maximizing columnar laminar flow.

2.6 Certification: UL Standard 507 for Safety Electric Fans, CAN/CSA C22.2#60335-1and UL 94 5VA as certified by nationally recognized testing laboratory. Acceptable laboratories include ETL, UL or other nationally recognized testing laboratories.

2.7 Identification: Permanently affixed manufacturer's nameplate including the following: Model Number, Serial Number, Motor Power Specifications, Country of Manufacture and Safety Marks: ETL (US & CA) & CE (EU).

2.8 Power Cord: 6 foot, 300-volt AC, UL rated. Motors within the range of 100-130VAC are provided with a standard 3-prong plug. Motors within the range of 200-277VAC are not provided with a plug.

2.9 Destratification fan shall be a suspended from structure Air Pear Model.
1. SF1:
   a. Size and Weight:
      1) Standard: 21.5 inch total height; 13 inch diameter; 10 lb.

b. Motor (EC): Electronically Commutated motor. Blades molded in one piece with hub. No lubrication required, bearings are sealed. Up to 550 CFM, 1650 RPM, 50 dBA. Thermally protected motor with an operating range of minus 22 degrees F to plus 122 degrees F.
   1) Recommended mounting height at 19 feet with 1 foot of clearance above fan.
   2) Electrical Requirements:
      a) 120V AC, single phase, 50/60 Hz.; 0.4/0.46 Amps; 30/35 watts
   3) Controls shall be coordinated with motor electrical requirements.
      a) Shall be destratification control based on differential temperature with temperature sensors mounted at floor level and fan level.

c.

PART 3 - EXECUTION

3.1 INSTALLATION

1. Install in accord with manufacturer's recommendations and as specified.
2.

END OF SECTION 23 3400

a.

SECTION 237433 – DEDICATED OUTDOOR AIR UNITS

PART 1: GENERAL

1.01 RELATED DOCUMENTS

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

1.02 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
B. AMCA 99—Standards Handbook
C. AMCA 500—Test Methods for Louver, Dampers, and Shutters.
D. AHRI 340/360 - Unitary Large Equipment
E. NEMA MG1—Motors and Generators
F. National Electrical Code.
G. NFPA 70—National Fire Protection Agency.
H. SMACNA—HVAC Duct Construction Standards—Metal and Flexible.
I. UL 900—Test Performance of Air Filter Units.

1.03 SUBMITTALS

A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics and connection requirements.
B. Product Data:
1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, and electrical characteristics and connection requirements.
2. Provide computer generated fan curves with specified operating point clearly plotted.
3. Manufacturer's Installation Instructions.

1.04 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Provide instructions for installation, maintenance and service

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.
B. Startup must be done by trained personnel experienced with rooftop equipment.
C. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters and remote controls are in place, bearings lubricated, and manufacturers' installation instructions have been followed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site.
B. Accept products on site and inspect for damage.
C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.07 EXTRA MATERIALS

A. Manufacturer shall provide one set of filters for balancing, one final set for owner turnover, and one additional set for storage. (3 sets total). Contractor shall be responsible for additional filters required during construction.

1.08 SYSTEM STARTUP

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

B. Comply with manufacturer's start-up requirements to ensure safe and correct operation and integrity of warranty.

PART 2: PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Valent

1. Approved Equal manufacturers: Addison, Greenheck, Trane, Daikin Applied

2.02 GENERAL DESCRIPTION

A. Furnish as shown on plans, Daikin Applied Rebel Single zone Heating and Cooling Unit(s) model DPS. Unit performance and electrical characteristics shall be per the job schedule.

B. Configuration: Fabricate as detailed on prints and drawings:

1. Return plenum / economizer section
2. Filter section
3. Cooling coil section
4. Supply fan section
5. Electric heating section.
6. Condensing unit section

C. The complete unit shall be cETLus listed.

D. The unit shall be ASHRAE 90.1-2016 compliant and labeled.

E. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.

F. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.

G. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.

H. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

I. Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

2.03 CABINET, CASING, AND FRAME

A. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 2" thick with an R-value of 13.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.

B. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16" at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.

C. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.

D. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.04 OUTDOOR/RETURN AIR SECTION

A. Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.

B. Daikin Applied UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.

C. Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when when supply fan starts, and close when supply fan stops.

2.05 ENERGY RECOVERY

A. The fixed plate energy recovery core is equipped with a bypass damper on the outside air path.

B. When the outside air is below 32F (adjustable) the bypass damper will open for 5 minutes (adjustable) every 60 minute period (adjustable). Exhaust air continues to run though the core during this time to remove frost buildup.

C. The ERV core shall transfer both sensible and latent energy between the incoming fresh air stream and the exhaust stale air stream.

D. The ERV core shall be in either a cross-flow or counter cross-flow orientation and have no moving parts.

E. The ERV core shall be certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. Products not currently AHRI certified will not be accepted.

F. The ERV core shall achieve the minimum effectiveness value as indicated in the schedule.

G. The fresh air stream must have complete separation from the stale air stream to prevent cross contamination.

H. The ERV core shall have Exhaust Air Transport Ratio of 0.5% as tested to AHRI 1060 (EATR) to prevent cross-over of gases, contaminants or odors.

I. The ERV core's Outdoor Air Correction Factor (OACF) shall not exceed 1.0 as tested to AHRI 1060 (OACF) Standard.

J. The ERV core shall not be degraded or promote the growth of mold and bacteria with a rating of zero in testing according to ISO846 A and C.

K. The ERV core must be able to tolerate freezing temperatures of -22°F and not have an increase in EATR or decrease in performance after being frozen.

L. The ERV core must be able to tolerate high temperatures of +140°F and not have an increase in EATR or decrease in performance at these elevated temperatures.

M. The ERV core must be freeze tolerant tested to 40 freeze thaw cycles from -4°F to +68°F while maintaining the energy recovery effectiveness and EATR rating of 0.5%.

N. The ERV core must be water washable to remove dust and contaminants.

O. The ERV core must be flame proof and comply with UL 723 with a flame spread index that shall not be over 25 and a smoke index that shall not be over 50.

P. The ERV cores should have particulate filters positioned before the incoming air streams.

Q. Accepted manufacturer: CORE Energy Recovery Solutions or approved equal, subject to compliance with requirements

2.06 EXHAUST FAN

A. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

B. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

C. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.07 FILTERS

A. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 and 4" MERV 14 filters.

2.08 COOLING COIL

A. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.

B. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube

design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.

C. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.

D. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

E. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

F. A drain pan over flow safety shall shut off the unit and issue a warning before over flow occurs.

2.09 HOT GAS REHEAT

A. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser

B. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.

C. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.

D. Each coil shall be factory leak tested with high-pressure air under water.

2.010 SUPPLY FAN

A. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

B. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide a L-50 life at 250,000 hours. The entire fan assembly shall be isolated from the fan bulkhead with a flexible collar and mounted on 1" spring isolators.

C. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.

D. Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.

E. The motor shall be T Frame and open drip proof. Overload protection and speed control is provided by the factory installed VFD and rooftop unit controller. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

F. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.011 HEATING SECTION

A. The rooftop unit shall include an electric heating section. The electric furnace design shall be one electric heating module factory installed downstream of the supply air fan in the heat section.

B. The module shall be complete with furnace controller and with infinitely variable SCR control.

C. The factory-installed DDC unit control system shall control the electric heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the electric heating modules.

2.012 CONDENSING SECTION

A. Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.

B. Outdoor air coils shall be protected from incidental contact to coil fins by a coil guard. Coil guard shall be constructed of cross wire welded steel with PVC coating.

C. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0~120°F. Mechanical cooling shall be provided to 0°F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.

D. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.

E. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and low oil safety protection.

F. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.

G. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

2.013 ELECTRICAL

A. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

B. A fused disconnect and 65,000 amp SCCR capability shall be provided.

C. Outlets: Provide a 115V GFI outlet mounted in a weatherproof enclosure.

2.014 CONTROLS

A. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature

sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.

B. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.

C. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.

D. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.

E. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.

F. Unit shall be provided with BACnet card for integration to BMS front end.

G. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:

1. Return air temperature.
2. Discharge air temperature.
3. Outdoor air temperature.
4. Space air temperature.
5. Outdoor enthalpy, high/low.
6. Compressor suction temperature and pressure
7. Compressor head pressure and temperature
8. Expansion valve position
9. Condenser fan speed
10. Inverter compressor speed
11. Dirty filter indication.
12. Airflow verification.
13. Cooling status.
14. Control temperature (Changeover).
15. Cooling status/capacity.
16. Unit status.
17. All time schedules.
18. Active alarms with time and date.
19. Previous alarms with time and date.
20. Optimal start
21. Supply fan and exhaust fan speed.

22. System operating hours.
    a. Fan
    b. Exhaust fan
    c. Cooling
    d. Individual compressor
    e. Heating
    f. Tenant override

H. The user interaction with the keypad shall provide the following:
1. Controls mode
    a. Off manual
    b. Auto
    c. Heat/Cool
    d. Cool only
    e. Heat only
    f. Fan only
2. Occupancy mode
    a. Auto
    b. Occupied
    c. Unoccupied
    d. Tenant override
3. Unit operation changeover control
    a. Return air temperature
    b. Space temperature
    c. Network signal
4. Cooling and heating change-over temperature with deadband
5. Cooling discharge air temperature (DAT)
6. Supply reset options
    a. Return air temperature
    b. Outdoor air temperature
    c. Space temperature
    d. Airflow (VAV)
    e. Network signal
    f. External (0-10 vdc)
    g. External (0-20 mA)
7. Temperature alarm limits
    a. High supply air temperature
    b. Low supply air temperature
    c. High return air temperature
8. Lockout control for compressors.
9. Compressor interstage timers
10. Night setback and setup space temperature.
11. Building static pressure.
12. Economizer changeover
    a. Enthalpy
    b. Drybulb temperature
13. Currently time and date

14. Tenant override time
15. Occupied/unoccupied time schedule
16. One event schedule
17. Holiday dates and duration
18. Adjustable set points
19. Service mode
    a. Timers normal (all time delays normal)
    b. Timers fast (all time delays 20 sec)

I. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:

1. Zone sensor with tenant override switch
2. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)

J. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:

1. Airflow
2. Outside air temperature
3. Space temperature
4. Return air temperature
5. External signal of 1-5 vdc
6. External signal of 0-20 mA
7. Network signal

2.015 ROOF CURB

A. A grade mounted plenum curb will be supplied to allow side return and side supply air streams. Unit dimensions will be coordinated to match the RTU openings and shared with the structural engineer for coordination with concrete pad.

PART 3: EXECUTION

3.01 INSTALLATION

A. Install equipment per industry standards, applicable codes, and manufacturer's instructions.

B. Do not use DOAS for temporary heating, cooling or ventilation prior to complete inspection and startup performed per this specification.

C. Install DOAS on a roof curb as shown on drawings.

D. Install DOAS with manufacturer's recommended clearances for access, coil pull, and fan removal.

E. Install DOAS plumb and level. Connect piping and ductwork according to manufacturer's instructions.

F. Install insulation on all staggered coil piping connections, both internal and external to the unit.

3.02 FIELD QUALITY CONTROL

A. Store per DOAS manufacturer's written recommendations. Store DOAS indoors in a warm, clean, dry place where units will be protected from weather, construction traffic, dirt, dust, water and moisture. If units will be stored for more than 6 months, follow manufacturer's instruction for long-term storage.

B. Rig and lift units according manufacturer's instructions.

3.03 RTU INSPECTION

A. Hire manufacturer's factory-trained and factory-employed service technician to perform an inspection of unit and installation prior to startup. Technician shall inspect and verify the following as a minimum:

1. Damage of any kind
2. Level installation of unit
3. Proper reassembly and sealing of unit segments at shipping splits.
4. Tight seal around perimeter of unit at the roof curb
5. Installation of shipped-loose parts, including filters, air hoods, bird screens and mist eliminators.
6. Completion and tightness of electrical, ductwork and piping
7. Tight seals around wiring, conduit and piping penetrations through RTU casing.
8. Supply of electricity from the building's permanent source
9. Integrity of condensate trap for positive or negative pressure operation
10. Condensate traps charged with water
11. Removal of shipping bolts and shipping restraints
12. Sealing of pipe chase floor(s) at penetration locations.
13. Tightness and full motion range of damper linkages (operate manually)
14. Complete installation of control system including end devices and wiring
15. Cleanliness of DOAS interior and connecting ductwork
16. Proper service and access clearances
17. Proper installation of filters
18. Filter gauge set to zero

3.04 STARTUP SERVICE and OWNER TRAINING

A. The services of a factory trained Field Engineer shall be provided for assistance in initial system startup and adjustment. The Field Engineer shall provide one day of startup per DOAS. Manufacturer's factory-trained and factory-employed service technician shall startup DOAS. Technician shall perform the following steps as a minimum:

1. Energize the unit disconnect switch
2. Verify correct voltage, phases and cycles
3. Energize fan motor briefly ("bump") and verify correct direction of rotation.
4. Re-check damper operation; verify that unit cannot and will not operate with all dampers in the closed position.
5. Energize fan motors and verify that motor FLA is within manufacturer's tolerance of nameplate FLA for each phase.
6. Charge refrigerant coils with refrigerant and test for leaks.

B. Provide a minimum of 4 hours of training for owner's personnel by manufacturer's factory-trained and factory-employed service technician. Training shall include DOAS controls, motor starter, VFD, and DOAS.

C. Training shall include startup and shutdown procedures as well as regular operation and maintenance requirements.

D. Submit a startup report summarizing any problems found and remedies performed.

3.05 FIELD PERFORMANCE VERIFICATION

A. Leakage: Pressurize casing to maximum operating static pressure and measure leakage. If leakage exceeds 1% of design airflow, seal leakage points with a permanent solution. Repeat test. If the DOAS still does not pass, contact the manufacturer to seal unit.

B. Submit a field test report with testing data recorded. Include description of corrective actions taken.

3.06 CLEANING

A. Clean unit interior prior to operating. Remove tools, debris, dust and dirt.

B. Clean exterior prior to transfer to owner.

3.07 DOCUMENTATION

A. Provide Installation Instruction Manual, & Startup checklist in the supply fan section of each unit.

END OF SECTION

SECTION 238149 – GROUND SOURCE HEAT PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fluid to air extended range units.

1.2 RELATED SECTIONS

A. Refer to Division 26 for electrical power wiring requirements from the source to the power connection on the water-source heat pump units. Information to be referenced include: electrical characteristics, circuit protection, wiring and unit connection methods.

B. Section 230553 – Identification for HVAC Piping and Equipment.

C. Section 230548 – Vibration Control for HVAC Piping and Equipment.

D. Section 230900 – Instrumentation and Control for HVAC.

E. Section 232116 – Hydronic Specialties.

1.3 CODES AND STANDARDS

A. NFPA 70 – National Electrical Code.

B. UL Listing and Compliance – Units are to be designed, constructed, and assembled to meet or exceed all applicable Underwriters' Laboratories safety requirements. Units must be listed and labeled as having met UL safety standards.

C. ASHRAE 90A – "Energy Conservation in New Building Design".

D. ARI/ASHRAE/ISO Standard 13256-3 – Ground-Loop Heat Pump.

1.4 SUBMITTALS FOR REVIEW

A. Submit manufacturer's technical product data including:

1. ARI certified heating and cooling capacities at ISO 13256-3 conditions.
2. Electrical power input and ARI certified unit efficiency at ISO 13256-3 conditions.
3. Water pressure drop through unit and furnished unit hydronic specialties at specified flow rates.

1.5 SUBMITTALS FOR INFORMATION

A. Submit manufacturer's technical product data including:

1. Detailed dimensional drawings – provide unit drawings from manufacturer that indicate all necessary dimensional data including: overall unit size and operating weight, unit service access panels and required clearances, ductwork connections, electrical, and plumbing connections.
2. Complete unit electrical data including: rated operating voltage, total unit full load amperage, minimum circuit amperage, maximum fuse/HACR breaker size and wiring diagrams. Wiring diagrams should clearly differentiate between the portions of the wiring that are factory-installed and portions that are field-installed.
3. Furnished system specialties and accessories.
4. Installation instructions – indicating assembly, support details, connection requirements, and system start-up instructions.

1.6 SUBMITTALS FOR CLOSEOUT

A. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and trouble-shooting guides, and repair data including common repair parts.

B. Provide a detailed equipment schedule that includes: unit model and serial numbers, unit tag or identification, location, and air filter quantity and sizes.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five (5) years experience.

1.8 DELIVER, STORAGE, AND PROTECTION

A. Handle water source heat pumps and components carefully to prevent damage, breaking, denting, and scoring. Do not install damaged water source heat pumps or components; repair per factory guidelines or replace with new.

B. Store water source heat pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading water source heat pumps and moving units to final location for installation

1.9 WARRANTY

A. Warranty on Motor/Compressor: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors/compressors with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for

handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only and does not include labor for removal and reinstallation.

Standard Warranty Period: All Parts: 1 year from startup or 18 months from ship date

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. WaterFurnace International
B. Trane
C. Florida Heat Pump
D. ClimateMaster
E. Daiken Applied

2.2 General

A. Description: Equipment shall be completely assembled, piped, and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow. The reverse cycle heating/cooling units shall be floor-mounted type with horizontal air inlet and vertical upflow air discharge. Units shall be AHRI/ ISO 13256-1 certified and listed by a nationally recognized safety-testing laboratory or agency, such as UL Testing Laboratory. Each unit shall be computer run-tested at the factory with conditioned water and operation verified to catalog data. Each unit shall be mounted on a pallet and shipped in a corrugated box or stretch-wrapped. The units shall be designed to operate with entering liquid temperature between 20°F and 120°F

2.3 Casing and Cabinet

A. Cabinet: The cabinet shall be fabricated from heavy-gauge galvanized steel and finished with optional corrosion-resistant powder coating. This corrosion protection system shall meet the stringent 1000-hour salt spray test per ASTM B117. The interior shall be insulated with 1/2 in. thick, multi-density, cleanable aluminum foil coated glass fiber with edges sealed or tucked under flanges to prevent the introduction of glass fibers into the discharge air. Standard cabinet panel insulation must meet NFPA 90A requirements, air erosion and mold growth limits of UL-181, stringent fungal resistance test per ASTM-C1071 and ASTM G21 and shall meet zero level bacteria growth per ASTM G22. Unit insulation must meet these stringent requirements or unit(s) will not be accepted.

B. Two blower and two compressor compartment access panels shall be 'lift-out' removable with supply and return ductwork in place.

C. A duct collar shall be provided on the supply air opening. The upflow vertical units shall have a removable insulated divider panel between the air handling section and the compressor section to minimize the transmission of compressor noise and to permit

operational service testing without air bypass. Vertical units shall be supplied with left or right horizontal air inlet and top vertical air discharge.

D. The compressor shall be double isolation mounted using selected durometer grommets to provide vibration free compressor mounting. The compressor mounting bracket shall be acoustically deadened galvanized steel to prevent vibration transmission to the cabinet.

2.4 Air Filter System

A. The Contractor shall completely assemble an Air Filter System for each unit and install ready to use. Heat pumps 5 tons and smaller require one 24" X 24" air filter system (one 24 X 24 filter). Heat pumps 6 tons through 10 tons require one 48" X 24" air filter system (two 24 X 24 filters). See plans for sizes and quantities. Refer to Specification Section 230500 General Mechanical Requirements for Temporary Use of Equipment Requirements and filter quantities.

B. Side Access Filter Housing: Housings shall accommodate required quantity of 24" X 24" X 2" deep flat filters as noted above. Housings shall be factory assembled, have one hinged access door with quick access latches (operable without special tools), and be constructed on 16 gauge aluminized steel minimum.

C. Filters shall be 30% efficient MERV 8, pleated and disposable. Provide Flanders/FFI Pre Pleat 40, 24" x 24" x 2" thick or approved equal. The filter pressure drop shall be 0.28" at 500 fpm face velocity. Each filter shall consist of a non-woven cotton and synthetic fabric media, media support grid and enclosing frame. The filter shall be listed by Underwriters' Laboratories as Class 2.

2.5 Refrigeration Circuit

A. Refrigerant to Water Heat Exchanger: Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 600 psig working refrigerant pressure and 450 psig working water pressure. ThermaShield coated water-to-refrigerant heat exchanger, water lines and refrigerant suction lines shall be insulated to prevent condensation at low liquid temperatures below 50°F.

B. Refrigerant to Air Heat Exchanger: All aluminum air coils (7-10 ton) are constructed of all-aluminum round tube and high efficiency lanced fin design. All aluminum interlaced air coils (12-30 ton) are constructed for interlaced dual compressor circuit operation using high efficiency lanced fin design with all aluminum construction. Interlacing the coil circuits allows part load airflow operation and higher efficiencies.

C. All units shall utilize the non-ozone depleting and low global warming potential refrigerant R-410A. All units shall contain a sealed refrigerant circuit including a hermetic motor-compressor, bidirectional electronic expansion valve, finned tube air-to-refrigerant heat exchanger, reversing valve, coaxial heat exchanger, and service ports.

D. Compressor:

1. 0 to 2 Tons Capacity: Compressors shall be high-efficiency single speed rotary or scroll type designed for heat pump duty and mounted on vibration isolators. The compressor shall be double isolation mounted using selected durometer grommets to provide vibration free compressor mounting.

2. 2 to 6 Tons Capacity: Permanent magnet compressors coupled with high efficiency electronic drives to allow capacity modulation between 25 and 100% shall be used. The compressor shall be double isolation mounted using selected durometer grommets to provide vibration free compressor mounting.
3. 6 to 15 Tons Capacity: Compressors shall be high-efficiency permanent magnet motor, scroll type designed for variable capacity heat pump duty and mounted on vibration isolators.

E. Water-to-refrigerant heat exchanger, water lines and refrigerant suction lines shall be insulated to prevent condensation at low liquid temperatures below 50°F.

F. Refrigeration Components: Provide 4-way, electro-magnetically activated solenoid refrigerant reversing valve designed for fail-safe operation in the heating position. The solenoid coil assembly must be detachable from valve body. Provide a bi-directional, thermostatic expansion valve to deliver proper superheat over the complete range of operating water temperatures. Provide a liquid line filter dryer within the refrigerant circuit to maintain system integrity.

2.6 Blower Motor and Assembly

A. The blower shall be a direct drive centrifugal type with a dynamically balanced wheel. The housing and wheel shall be designed for quiet low outlet velocity operation. The blower housing shall be removable from the unit without disconnecting the supply air ductwork for servicing of the blower motor. The blower motor shall be isolated from the housing by rubber grommets. The motor shall be permanently lubricated and have thermostatic overload protection.

B. The blower motor shall be a variable speed ECM type. The variable speed ECM blower motor shall be soft starting, shall maintain constant cfm over its operating static range, and shall provide 12 cfm settings. Variable speed ECM motors shall be long-life ball bearing type.

2.7 Electrical

A. A control box shall be located within the unit compressor compartment and shall contain a 50VA or 75VA transformer, 24 volt activated, 2 pole compressor contactor, terminal block for thermostat wiring and solid-state controller for complete unit operation. Electromechanical operation WILL NOT be accepted. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 volt and provide heating or cooling as required by the remote thermostat/sensor.

B. Electronic Controls: An Aurora Unitary Protocol Converter (UPC) shall be included that communicates directly with the Aurora Heat Pump Controls and allows access/control of a variety of internal Aurora heat pump operations such as sensors, relay operation, faults and other information. In turn, the UPC shall convert the internal Aurora Modbus protocol to BACnet MS/TP protocol for communication over a BAS system. Additional individual unit configuration items such as ECM fan speeds or freeze protection settings shall be directly available over the BAS without the need for access to the actual heat pump.

C. Provide temperature sensor with temperature conversion, override, LCD display, and set point adjustment

D. Coordinate all temperature control work with the BAS control manufacturer section 230900

2.8 Piping

A. Supply and return water connections shall be FPT copper fittings fixed to the corner post, which eliminate the need for backup pipe wrenches.

2.9 Condensate and Drain Pan

B. The condensate connection shall be a ¾ in. PVC socket with internally-trapped hose that can be routed to front or side corner post locations.

2.10 Hose Kit and Piping Package

A. Hose kits and piping package shall be as scheduled on the drawings. Single piece hose kits shall be provided for hose kits that are 1-1/2" or less in size. Two piece hose kits shall be provided for hose kits that are 2" and larger in size. Hose kits shall be the pipe runout size, not heat pump connection sizes. No exceptions!

B. Provide a factory-assembled hose kit/piping package for supply and return connections for each heat pump. Kits may be mounted in any direction and shall not require straight sections of pipe either upstream or downstream for proper operation. All hoses shall be equipped with end connections at terminal unit and shall be 24" long. All end connections shall be either permanently crimped swivel ends or butt welded to carbon steel end fittings to meet stated pressure ratings. Operational temperature shall be rated from fluid freezing to 200 degrees F. Minimum burst pressure shall be four times the working pressure. Furnish with field flushing connection fitting. Up to 1-1/4" shall be reinforced, fire retardant EPDM rubber, bonded to the inside wall of braiding. 1 ½" and larger shall be a corrugated type 321 stainless steel tube.

C. Each supply side (water inlet) hose kit/piping package shall include a single piece Y - valve body for sizes up to 1-1/2" and shall be constructed of hot forged brass with threaded inlets and outlets. 2" and larger sizes shall be two-piece and constructed of

ductile iron with threaded inlets and outlets. All valve bodies are suitable for a minimum of 400 PSIG working pressure. Include single pressure/temperature test ports for verifying the pressure differential and system temperature. Include full flow design ball valve with blow out stems for shut off. Strainer shall be Y-type configuration furnished with hose connector blow down valve. Strainer screen shall be stainless steel mesh and easily accessible for cleaning without disconnecting hoses. All valves shall be labeled with flow direction, manufacturer and model number, unit tagging.

D. Each return side (water outlet) hose kit/piping package shall include a single piece Y - valve body for sizes up to 1-1/2" and shall be constructed of hot forged brass with threaded inlets and outlets. 2" and larger sizes shall be two-piece and constructed of ductile iron with threaded inlets and outlets. All valve bodies are suitable for a minimum of 400 PSIG working pressure. Include single pressure/temperature test ports for verifying the pressure differential and system temperature. Include full flow design ball valve with blow out proof stems for shut off. All valves shall be labeled with flow direction, manufacturer and model number, unit tagging. Include automatic flow control valves which shall be factory set to rated flow and shall automatically control the flow to within 10% of the rated value subject to the operating parameters of 2-80 psid, fluid freezing to 225°F, 2-7 fps. Also provide a Belimo three-wire, two-way, two-position control valve (ball) with actuator. Actuator shall be field installed by the TCC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install extended range water-source heat pumps in accordance with manufacturer's written instructions.

B. Install units with adequate clearance from obstructions to allow for servicing and filter replacement.

C. Coordinate installation of units with work being performed by other trades or contractors.

3.2 CONNECTIONS

A. Ground Loop Water Piping: Connect supply and return piping to heat pump as indicated, with unions and shutoff valves. All unit supply and return piping is to be insulated. Provide Field installed water strainers to prevent particulate debris from obstructing water flow through the water to refrigerant heat exchangers.

B. Electrical: Install all electrical devices furnished, but not specified to be factory mounted. Verify that unit is properly grounded and that wiring connections are in accordance with manufacturer's written documentation.

3.2 FIELD QUALITY CONTROL

A. General: Start-up heat pump units in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements with Project Manager on site to witness test. Replace damaged or malfunctioning controls and equipment.

3.3 DEMONSTRATION

A. Provide the services of a factory-authorized representative for one day to instruct the Owner's personnel as specified:

1. Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.
2. Review data in the maintenance manuals specified in Section 1.6.
3. Schedule training with Owner, through Project Manager, with at least 7 days' advance notice.

END OF SECTION 238149

SECTION 238236 - ELECTRIC BASEBOARD HEATERS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. Provide electric baseboard heaters, complete with internal thermostat controls.

1.3 QUALITY ASSURANCE

A. Standards: Underwriters' Laboratories (UL) label.

1.4 RATINGS AND CAPACITIES

A. Refer to the Drawings for arrangements, voltage, wattage and other design requirements.

1.5 MANUFACTURERS

A. Indeeco, Qmark, Chromolox, Trane, **Raywall (Addendum 2),** or approved equal.

PART 2 - PRODUCTS

2.1 ELECTRIC BASEBOARD HEATERS

A. General Construction: 20 gauge steel, all required controls and thermostats.

B. Heating Element:
   1. Electric Heating: Stainless steel tubular heating element with aluminum fins. Floating heating element on high-temperature nylon bushings reducing expansion noises.

C. Controls: Disconnect switch and thermal overheat protector.
   1. Wall-mounted adjustable thermostat.

D. Finish: Submit available grille style and color charts for final color selection by Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Must be installed inside a trench under a floor with a compatible top trench grille, which must cover the entire length of the heater.

3.2 WIRING

A. Power wiring is the responsibility of the Electrical Contractor.

END OF SECTION 23 8236

SECTION 238239 - UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. Description of Systems
   1. Electric Unit Heaters
   2. Electric Cabinet Unit Heaters

1.3 QUALITY ASSURANCE

A. Standards
   1. ADC Standard 1062R2, Air Diffusing Equipment Test Code.
   2. AMCA Standard 210, Test Code for Air Moving Devices.
   3. ASHRAE Standard 70, Method of Testing and Rating the airflow performance of outlets and inlets.
   4. NFPA 90 A, Standard for the Installation of Air Conditioning and Ventilating Systems, 2018 Edition.
   5. ETL or UL Listed.

1.4 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section "Submittals".

B. Shop Drawings: All equipment items specified, including fan curves.

C. Product Data: Catalog cuts, performance data, fan curves, and sound data.

D. Contract Close-Out Information
   1. Operating and maintenance data.
   2. Contracting Officer's Representative's instruction report.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The following manufacturers are approved for use and shall meet the specified, scheduled and noted project requirements.
   1. Markel
   2. QMark
   3. Indeeco
   4. Raywall
   5. Chromalox
   6. Or approved equal

2.2 WALL HEATER (ECUH1)

A. Heating Elements:
1. Steel finned tubular elements.

B. Outlet Grille:
1. 18 gauge steel grille with rounded corners and a polyester power paint finish in white or almond. The external thermostat adjustment knob can be replaced with the concealing plug provided for tamperproof construction.

C. Built-in Controls:
1. Automatic reset thermal cutout, over-temperature warning light, fan override and thermostat.

D. Fan Motor:
1. Permanently lubricated, totally enclosed motor.

2.3 STANDARD ELECTRIC UNIT HEATER (EUH1)

A. Electric Commercial Unit Heaters with controls built-in and factory pre-wired. Heater is to be a forced fan type, UL Listed, of the KW rating, voltage and phase specified on the drawings.

B. Finned tubular heating elements shall have steel type fins epoxy sealed for moisture resistance.

C. Built-in controls include adjustable thermostat, automatic and manual rest over temperature cutout, 24V control transformer, fan delay relay, required contactors, disconnect switch, and summer fan switch.

D. Fan motor is permanently lubricated and thermally protected.

E. Cabinet shall be heavy gauge steel protected from corrosion by either a galvanized coating or a durable baked on polyester powder coat finish.

F. Outlet grille shall have individually adjustable directional louvers. In addition, an outlet protective grille shall prevent debris from reaching the element compartment. Inlet grille shall comply with OSHA requirements for a fan blade guard.

G. Single point electrical connection.

H. Miscellaneous: Wall/heater bracket or surface mounting adapter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall comply with latest issued manufacturer's published instructions and all applicable inspection and code authority requirements.

B. Verify applicable voltage, phase, and protective device requirements with electrical contractor before manufacture or installation of equipment.

END OF SECTION 23 8239

SECTION 260010

GENERAL REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each Sub Contractor's work. Each Contractor is directed to familiarize themself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

C. Each Contractor shall be governed by any alternates, unit prices and Addenda or other contract documents insofar as they may affect their part of the work.

1.2 SUMMARY

A. Section Includes general requirements applicable to work specified in Divisions 26, 27, and 28.

B. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of complete and operating Electrical Systems indicated on the drawings and/or specified herein.

C. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Electrical Systems in a substantial manner, in compliance with the requirements stated, implied, or intended in the drawings and specifications, shall be included as part of this Contract. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in their bid, and that they will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

D. It is not the intent of this section of the specifications (or the remainder of the contract documents) to make any specific Contractor, other than the Contractor holding the prime contract, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be done through the Contractor to the Architect (if applicable), then to the Engineer.

E. This section of the Specifications or the arrangement of the contract documents shall not be construed as an attempt to arbitrarily assign responsibility for work, material, equipment or services to a particular trade Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

F. Any reference within these specifications to a specific entity, i.e., "Electrical Contractor" is not to be construed as an provide to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor holding the prime contract, unless otherwise provided herein.

G. In each of the specifications and drawings referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

H. Intent and Interpretation

1. It is the intent of these specifications and all associated drawings that the Contractor provide finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete, tested and ready for operation."
2. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.
3. It is the intention of the Contract Documents to call for a complete and operational system, including all components, accessories, finish work, etc. as necessary for trouble free operation; tested and ready for operation. Anything that may be required, implied, or inferred by the Contract Documents shall be provided and included as part of the Bid.
4. All Contractors and Vendors providing a bid for this project shall review the Plans and Specifications and determine any modifications and/or adjustments necessary relative to the proposed equipment and materials with specific manufacturer's installation requirements. Include in the bid any necessary installation methods, features, options, accessories, etc. necessary to install the proposed equipment and materials, regardless of whether used as basis of design or being offered as a substitution in accordance with the specific manufacturer's installation requirements whether specifically detailed or not within the Plans and Specifications.
5. The Bidder/Proposer shall completely review the Contract Documents. Any interpretation as to design intent or scope shall be provided by the Engineer/ Architect. Should an interpretation be required, the Bidder/Proposer shall request a clarification not less than ten days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event of any conflict, discrepancy, or inconsistency develops; the interpretation of the Engineer shall be final.
6. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in the bid, and that will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

I. Drawings and Specifications

1. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for approval before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractors shall, however, anticipate that additional offsets may be required and submit their bid accordingly.
2. The drawings and specifications are intended to supplement each other. No Contractor, bidder, proposer or supplier shall take advantage of conflict between them, or between parts of either, but should this condition exist, the Contractor or supplier shall request a clarification of the condition at least ten days prior to the submission of bids so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all

instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

3. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.
4. This Contractor shall make all their own measurements in the field and shall be responsible for correct fitting. They shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.
5. The Engineer shall reserve the right to make minor adjustments in location of conduit, fixtures, outlets, switches, etc., where they consider such adjustments desirable in the interest of concealing work or presenting a better appearance.
6. Each Contractor shall evaluate ceiling heights called for on Architectural Plans and ensure that these heights may be maintained after all mechanical and electrical equipment is installed. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.
7. Should overlap of work between the various trades become evident, this shall be called to the attention of the Engineer. In such an event, neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.
8. The Electrical drawings are intended to show the approximate location of equipment, materials, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions whether given in figures or scaled shall be verified in the field. In case of conflict between small- and large-scale drawings, the larger scale drawings shall take precedence.
9. The Electrical Contractor and their Sub-Contractors shall review all drawings in detail as they may relate to his work (structural, architectural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetration points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineers at least ten days prior to bids, for issuance of clarification by written addendum.
10. Where on any of the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornament or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

1.3 COST BREAKDOWN AND PAY APPLICATIONS

A. Within thirty days after acceptance of the Contract, each Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer or Architect. Payments will not be made until satisfactory cost breakdowns are submitted. Refer to Division 00 and 01 specification sections for additional requirements.

B. In addition to cost breakdowns by specification section, the following shall also be provided: Material and labor shall be listed separately. These items are in addition to items listed in Division 01 specifications. Pay special attention to required withholding percentages for startup, testing, documentation, acceptance, owner training, etc. The breakdown shall be minimally as follows:

1. Permitting
2. Mobilization
3. Electrical Submittals

4. Electrical Coordination Drawings
5. Temporary Power
6. Interior Lighting Materials & Labor
7. Exterior Lighting Materials & Labor
8. Lighting Controls Materials & Labor
9. Lighting and Lighting Controls Startup, Testing, & Verification (equal to 2.5% of Equipment Value)
10. Theatrical Lighting Materials & Labor
11. Theatrical Dimming System Materials & Labor
12. Electrical Distribution Equipment Materials & Labor
13. Electrical Distribution Equipment Startup, Testing, & Verification (equal to 2.5% of Equipment Value)
14. Electrical Distribution Equipment Power System Study & Field Adjusting
15. Feeders Materials & Labor
16. Branch Circuiting Materials & Labor
17. Service Grounding Materials & Labor
18. Surge Suppression Materials & Labor
19. Electrical Devices Materials & Labor
20. Cable Trays Materials & Labor
21. Underground Duct Banks Materials & Labor
22. Fire Alarm Materials & Labor
23. Fire Alarm System Startup, Testing, & Verification (equal to 5% of Equipment Value)
24. Low-Voltage Data/Voice Cabling Materials & Labor
25. Low-voltage Data/Voice Equipment Materials & Labor
26. Audio/Video Equipment and Cabling Materials & Labor
27. Access Controls Equipment and Cabling Materials & Labor
28. CATV Equipment and Cabling Materials & Labor
29. Security Equipment and Cabling Materials & Labor
30. Video Surveillance Equipment and Cabling Materials & Labor
31. Low Voltage Systems Startup, Testing, & Verification (equal to 5% of Equipment Value)
32. Owner Training
33. Punchlist
34. As-Built/Record Drawings
35. O&M Manuals
36. Warranty
37. Demobilization

1.4 REFERENCES

A. Abbreviations and Acronyms

1. A, AMP: Ampere
2. ADA: Americans with Disabilities Act.
3. AFF: Above Finished Floor
4. AFG: Above Finished Grade
5. AHJ: Authority Having Jurisdiction
6. AHU: Air Handling Unit
7. AIC: Amps Interrupting Capacity
8. ANSI: American National Standards Institute.
9. ASA: American Standards Association.
10. ASTM: American Society for Testing Materials.
11. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.
12. ATS: Automatic Transfer Switch
13. A/V: Audio/Visual
14. AWG: American Wire Gauge

15. BAS: Building Automation System
16. BFG: Below Finished Grade
17. BICSI: Building Industry Consulting Services International
18. C: Conduit
19. CB: Circuit Breaker
20. CFCI: Contractor Furnished, Contractor Installed
21. CFOI: Contractor Furnished, Owner Installed
22. CKT: Circuit
23. CLG: Ceiling
24. CT: Current Transformer
25. CM: Construction Manager
26. DDC: Direct Digital Building Controls
27. DOAS: Dedicated Outdoor Air System
28. DWG: Drawing
29. EC: Electrical Contractor
30. ELEV: Elevator
31. EM: Emergency
32. EPO: Emergency Power Off
33. FA: Fire Alarm
34. FAA: Fire Alarm Annunciator
35. FACP: Fire Alarm Control Panel
36. FCC: United States Federal Communications Commission
37. FFE: Finished Floor Elevation
38. FLA: Full Load Amps
39. G, GND: Ground
40. GFCI: Ground Fault Circuit Interrupter
41. GC: General Contractor
42. HOA: Hands Off Auto
43. HP: Horsepower
44. IDF: Intermediate Distribution Frame
45. IECC: International Energy Conservation Code
46. ISO: International Standards Organization.
47. IT: Information Technology
48. KVA: Kilovolt-Amperes
49. KW: Kilowatt
50. KWH: Kilowatts Hours
51. LRA: Locked Rotor Amps
52. LTG: Lighting
53. MC: Mechanical Contractor
54. MCA: Minimum Circuit Ampacity
55. MCB: Main Circuit Breaker
56. MDF: Main Distribution Frame
57. MDP: Main Distribution Panel
58. MLO: Main Lugs Only
59. MOCP: Maximum Overcurrent Protection
60. MSB: Main Switchboard
61. N/A: Not Applicable
62. NEC: National Electrical Code
63. NECA: Standards for Installation.
64. NEMA: National Electrical Manufacturers Association.
65. NESC: National Electrical Safety Code.
66. NFPA: National Fire Protection Association.
67. NIC: Not in Contract
68. NRTL: Nationally Recognized Testing Laboratory
69. NTS: Not to Scale
70. N/A: Not Applicable

71. OFCI: Owner Furnished, Contractor Installed
72. OFOI: Owner Furnished, Owner Installed
73. OSHA: Office of Safety and Health Administration.
74. P: Pole, Poles
75. PC: Plumbing Contractor
76. PIR: Passive Infrared
77. RFI: Request for Information
78. RIO: Rough-in Only
79. RM: Room
80. SPD: Surge Protection Device
81. SS: Stainless Steel
82. SWBD: Switchboard
83. TIA: Telecommunications Industry Association
84. TYP: Typical
85. UL: Underwriters Laboratories, Inc.
86. UON or UNO: Unless otherwise noted.
87. UG: Underground
88. V: Volt, Volts
89. VFD: Variable Frequency Drive
90. W: Watts
91. WG: Wire Guard
92. WP: Weather Proof
93. XFMR: Transformer

B. Definitions

1. Architect: The Architect of Record for the project, if applicable.
2. Basis of Design (BOD): Documentation of primary thought processes and assumptions behind design decisions made to meet design intent. Describes systems, components, conditions and methods chosen to meet intent.
3. Bidder/Proposer: Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.
4. Contract Documents: All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Manager's Assignments, Architect's Supplemental Instructions, Construction Contract with Owner, etc.
5. Contractor: Any Contractor whether bidding, proposing or working independently or under the supervision of a General Contractor, Prime Contractor, or Construction Manager and who installs any type of Electrical Work as specified in the Contract Documents.
6. Electrical Contractor: Any Contractor whether bidding or working independently or under the supervision of the entity holding the Prime Contract and who installs any type of Electrical work, such as: power, lighting, television, telecommunications, data, fiber optic, intercom, fire detection and alarm, security, video, underground or overhead electrical, etc.
7. Electrical Sub-Contractor: Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.
8. Engineer: The Consulting Mechanical-Electrical Engineer consulting to the Owner, Architect, or Other, etc.
9. Indicated: Listed in the Specifications, shown on the Plans or Addenda thereto.
10. Install: Install equipment furnished by others in complete working order.
11. Installer: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

12. Furnish: Deliver to the site in good condition and turn over to the Contractor who is to install.
13. Prime Contractor: The Contractor who has been engaged by the Owner in a contractual relationship to accomplish the work.
14. Project: All of the work required under this Contract.
15. Provide: Furnish and install complete, tested and ready for operation.
16. Start-Up: The activities where systems or equipment are initially tested and operated. Start-up is completed prior to functional testing.
17. Typical: Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.
18. Vendor: Supplier of equipment.

C. Reference Standards: Contractor is responsible for knowledge and application of current versions of all applicable standards and codes. Contractor shall adhere to the most recent revisions or version adopted by the Authorities Having Jurisdiction, including all relevant changes or addenda at the time of installation.

1. IEEE – Institute of Electrical and Electronics Engineers.
   a. IEEE C2, National Electrical Safety Code
2. NECA – National Electrical Contractors Association.
   a. NECA 1, Standard for Good Workmanship in Electrical Construction
3. NFPA - National Fire Protection Association.
   a. NFPA 70, National Electrical Code (NEC)
4. OSHA - The Occupational Safety and Health Act

1.5 COORDINATION

A. Utility Company Requirements

1. Contact the utility company for specifics on construction of pads, conduit, etc., prior to bidding the work and determine all their requirements. All work shall be in accordance with their standards.
2. Each contractor, prior to bidding the work, is to contact the utility companies (electric and telecommunications) and determine the exact points of extension of all underground services in the field with a representative of each utility company. Also, obtain construction details on manholes, transformer pads, pedestal stub-ups, etc., from each utility company as applicable. Extension points indicated on the plans are approximate, and are given for the bidder's information only.
3. The Contractor shall provide the local utility company with a drawing produced by a licensed Land Surveyor or a licensed Engineer and acceptable to the utility that locates the centerline of the service and connection point. Coordinate further requirements with utility company.
4. The Contractor is responsible for all fees, permit costs, etc., from the electrical utility, data, telephone and cable TV companies. This includes any cost associated with the underground electrical service extension.

B. Coordination with Existing Utilities and Structures

1. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that are present within the contract construction site, shall be subject to continuous uninterrupted maintenance with no exception unless the Owner of the utility grants permission for temporary interruption.

2. Known utilities and structures as available to the Engineer are shown on the drawings. However, it is additionally required that, prior to any excavation being performed, each Contractor ascertain and mark all utilities or lines that would be endangered by the excavation. Contractor shall bear costs of repairing damaged utilities.
3. If utilities or structures are installed within the construction project boundary, the Contractor shall first probe and make every effort to locate the lines prior to excavating in the respective area.
4. Cutting into existing utilities and services shall be done in coordination with and as designated by the Owner of the utility. The Contractor shall work continuously to restore service(s) upon deliberate or accidental interruption, providing premium time and materials as needed without extra claim to the Owner.
5. The Contractor shall repair to the satisfaction of the Engineer any surface or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.
6. Machine excavation shall not be permitted within ten feet of existing gas or fuel lines. Hand excavate only in these areas, in accord with utility company, agency or other applicable laws, standards or regulations.
7. Protect all new or existing lines from damage by traffic, etc. during construction.
8. Protect existing trees, indicated to remain with fencing or other approved method. Hold all new subsurface lines outside the drip line of trees, offsetting as necessary to protect root structures. Refer to planting or landscaping plans, or in their absence, consult with the Architect.

C. Interruption of Existing Services: In general, and to the extent possible, perform all work without interruption of the existing facilities' operations. Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify the Owner, Architect, and Engineer no fewer than seven days in advance of proposed interruption of service.
2. Provide the exact time the interruption will occur and the length of the interruption.
3. Do not proceed with interruption of service without written permission from Owner, Architect, and Engineer.
4. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.
5. Contractor will not be entitled to additional compensation due to work stoppage mandated by unscheduled interruption.
6. Coordinate interruptions with systems impacted by outages including but not limited to the following:

    a. Generators
    b. Emergency Lighting
    c. Elevators
    d. Fire Alarm Systems

7. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore the service. The Contractor shall provide tools, materials, skilled journeymen of their own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work.

D. Coordination Between Trades

1. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to their work, including Architectural, Mechanical, Structural and other pertinent Drawings, to the end that complete coordination between trades will be affected.

2. The Contractor is responsible for the correct location of all rough-in and connections at every piece of equipment. Work not correctly located shall be relocated at the Contractor's expense.
3. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.
4. Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than ¼ inch = 1 Foot, clearly indicating how his work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. The Contractor shall make the necessary changes in his work to correct the condition without extra charge.
5. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

E. Temporary Services

1. The Contractor shall arrange for temporary electrical and other services required to accomplish the work. In the absence of other provisions in the contract, the Contractor shall provide for temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in their bid.
2. All temporary services shall be removed by Contractor prior to acceptance of work.

F. Temporary Use of Equipment

1. The permanent electrical equipment, when installed, may be used for temporary services, subject to an agreement among the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without additional cost to the Owner, leaving the equipment and installation in "as new" condition. The Contractor may be required to bear utility costs, user fees, etc.
2. Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result from its use.

G. Preinstallation Conference

1. Conduct a preinstallation conference at project site before each construction activity when required by other Sections and when required for coordination with other construction.
2. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Engineer of scheduled meeting dates.
3. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including any possible conflicts, requirements, limitations, and coordination with other work.
4. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
5. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
6. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date

1.6 SUBMITTALS

A. Review of submittals by the Engineer applies only to conformance with the design intent of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

B. The Engineer's review of submittals, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

C. If a submittal deviates from the drawings or specifications because of Contractor's standard practice, approved substitution request, or any other reason, the submittal shall notify the designer of the deviation.

D. Prior to the start of work the contractor shall submit the following. Work shall not proceed without the Engineer's and Owner's completed review of the submitted items.

E. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
2. Clearly and precisely mark red notations and yellow highlights on the submittal to show which products and options are applicable.
3. Include the following information, as applicable:
    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Rated capacities, operating characteristics, and electrical characteristics,
    i. Wiring diagrams that show factory-installed wiring and interface points.
    j. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
4. Format and Organization: submit bookmarked electronic PDF files complying with the following:
    a. Cover: Clearly display the following information: Owner name, Project name, Submittal name, project submittal number, Contractor name and contact information, and applicable specification section numbers.
    b. Table of Contents: Include a TOC that lists materials by section number, with a brief product description, manufacturer and part number, and list the submittal page number per product
    c. Product Information

F. Product Schedules: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.

2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.

G. Shop Drawings: Prepare Project-specific information, drawn accurately to scale.

1. Shop Drawings that are reproductions of the Contract Documents are not permitted and will be rejected.
2. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Mounting Details
   c. Wiring diagrams and installation details
   d. Identification of products.
   e. Schedules.
   f. Compliance with specified standards.
   g. Notation of coordination requirements.
   h. Notation of dimensions established by field measurement.
   i. Seal and signature of professional engineer if specified.

H. Coordination Drawings:

1. Detailed electronic coordination drawings shall be required for this project. The Engineer and the Engineer's Construction Administrator shall closely monitor progress and quality of the preparation of the electronic coordination drawings and may withhold pay requests as deemed appropriate.
2. Coordination Drawings shall be provided on this project by each Trade. Drawings shall be 30x42 sheet size and shall be at ¼-inch scale and shall match the drawing setup as included in the Architectural Drawings. Drawings shall be prepared in electronic format utilizing AutoCad software. The Architect and Engineer will supply electronic drawings files of the Contract Documents upon the Contractor's request and release.
3. The basis for the Coordination Drawings shall be the sheet metal ductwork fabrication shop drawings, all electrical feeder conduits, groupings of branch circuit conduits, other conduits 2" and larger, and pneumatic tube system piping and components in ceiling spaces. These drawings shall indicate all ductwork as double lined with bottom elevations noted. The Coordination Drawings shall indicate:
   a. Systems above ceilings in finished areas,
   b. Systems supported from the structure in finished areas without ceilings,
   c. Systems in the mechanical rooms, and
   d. All wall, roof, floor penetrations.
4. The sheet metal fabrication shop drawings shall be completed in a timely manner so as not to conflict with construction schedule and phasing plan. At the Prime Contractor's discretion, these drawings shall be completed in phases to correspond with the project construction work sequencing. The Mechanical Contractor shall furnish an electronic copy of these ductwork shop drawings to all other Trades, specifically the Fire Protection and Electrical and other Contractors as requested by the Prime Contractor for the purpose of including other trades work on the Coordination Drawings.
5. Pre-Coordination Meetings with all necessary trades shall occur. During these meetings, the Contractors shall discuss locations/elevations where piping, conduits, cable path, etc. will be installed with respect to the sheet metal fabrication drawings and other trades. The sheet metal ductwork and gravity piping systems shall be given the first priority. Within 30 days of the meeting, each Trade shall provide the Mechanical Contractor electronic drawings of all of their systems (with elevation noted), coordinated with the ductwork and other trades for them to incorporate into the Coordination Drawings. Coordination Meetings shall then occur so that all conflicts can be resolved between Trades. All conflicts

shall be resolved between all Trades at these Coordination Meetings and the Mechanical Contractor shall then amend the Drawings to include the Final Coordinated Work.

6. It is realized that not all systems can be completely detailed. The coordination drawings shall include the following at a minimum:
   a. All supply/return/exhaust ductwork.
   b. All above slab sanitary and roof drainage piping.
   c. HVAC, fire protection and domestic water piping which are 2" in size and greater, excluding insulation.
   d. Gas mains.
   e. Electrical conduits which are 1.5" in size and greater.
   f. J-hook and cable tray cabling paths
   g. Groupings of smaller piping/conduits hung on a common hanger.
   h. All wall, roof, floor penetrations.
   i. Light fixtures.
7. After completion of the Final Coordination Drawings, a Final Review with the all Trades shall occur to provide any final comments and approval by all Trades. Other interim coordination meeting will be required to ensure successful coordination drawings. Any additional coordination items will be updated by the Mechanical Contractor. The Final Approved Coordination Drawings shall be distributed electronically (on CD) to each Trade by the Mechanical Contractor. The Mechanical Contractor shall also furnish a complete 30x42 paper set of drawings to the jobsite main office and shall utilize them for updates of field conditions/deviations that occur during construction. Final Approved Coordination Drawings shall also be distributed to the Construction Manager, Owner, Architect and Engineer for their Records. This process shall be completed prior to starting any work.
8. Each Contractor shall ensure that any deviations from the Coordination Drawings are recorded as they occur, in red erasable pencil on record drawings kept at the jobsite. Upon completion of a particular phase, the Mechanical Contractor shall incorporate all field deviations into the Coordination Drawings to be utilized as Record Drawings. The Engineer shall review the Record Documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. The Record Drawings shall be distributed electronically (on CD) to the Construction Manager, Owner, Architect and Engineer for their Records.
9. The Mechanical Contractor is responsible to the Prime Contractor for the shop drawing layout of the following rooms and details:
   a. Concrete pads and foundations
   b. Equipment room layouts with actual equipment
   c. Roof layouts
   d. Trench locations and sizes
   e. Dimensioned floor drain locations
   f. Congested areas above ceilings adjacent to mechanical and electrical rooms
   g. Dimensioned ductwork shop drawings
10. The Electrical Contractor is responsible to the General Contractor for the shop drawing layout of the following rooms and details:
   a. Concrete pads and foundations
   b. Equipment room layouts with actual equipment
   c. Routes of feeder conduits and all other conduits 1.5" and larger
   d. J-hook and cable tray cabling paths
   e. Trench locations and sizes
   f. Congested areas above ceilings adjacent to mechanical and electrical rooms
   g. Refer to Part 41 for additional requirements.
   h. Light fixture locations
   i. Exact layouts of all work in open ceiling areas

I. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

J. Closeout Submittals

1. Upon substantial completion of the project, provide a minimum of three bound copies with complex index and tabs to locate each item described below along with digital copy in PDF format on USB storage media.
2. As-Built Record Documentation
   a. The Contractor shall insure that any deviations from the design are being recorded daily, as necessary, on record drawings being maintained by the Contractor. Dimensions from fixed, visible permanent lines or landmarks shown in vertical and horizontal ways shall be utilized. Compliance shall be a requirement for final payment. Pay particular attention to the location of underfloor or underground exterior in-contract or utility-owned or leased service lines, main switches and other appurtenances important to the maintenance and safety of the Electrical System. Deliver these record drawings to the Engineer as a system is completed, within ten days of the mark-up and/or while the accuracy of the mark-ups can be verified visually. Monthly payment may be withheld if the requirement is not complied with.
   b. All underground utilities/piping installed as part of this project shall be surveyed by a land surveyor licensed in the State where the Work is being performed. This shall include underground electrical primary, communications, and structures. The survey shall include actual duct bank depths to top of conduit every 100 feet in length. The survey shall also include benchmarks dimensions relative to above grade, fixed structures. The survey shall be furnished on electronic storage media in AutoCad ".dwg" format and ".pdf" format. The survey information shall be included in the closeout documentation.
   c. Refer to additional record drawing requirements within the general conditions and other sections of these specifications.
3. Start-Up and System Testing Certificates
   a. Provide reports from all required testing to indicate procedures followed and complete results of all tests. Provide reports on manufacturer's standard forms for all equipment and system tests. Testing reports shall indicate applicable NEC, NFPA, UL, NETA, and/or ANSI standards.
4. Operation and Maintenance Manuals
   a. Provide operation and maintenance instructions and parts lists for all equipment provided in this contract. Formatting and content shall follow the guidelines outlined in the latest version of ASHRAE Application Handbook, Guideline.
   b. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
   c. The operation and maintenance document directory should provide easy access and be well organized and clearly identified.
   d. The operation and maintenance manuals shall contain the following information:
      1) Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
      2) Provide contacts (company name, address, phone number, email) where parts may be purchased for each principal item of equipment.
      3) Provide detailed maintenance instructions, including recommended preventative maintenance schedules for all equipment requiring maintenance. For lighting and lighting controls, provide recommended driver replacement schedule, provide a schedule for inspecting and recalibrating lighting controls, and provide a recommended settings list for all components with adjustable settings.

4) General Information. Provide the following:
   a) Building function
   b) Building description
   c) Operating standards and logs
5) Technical Information. Provide the following:
   a) System description
   b) Operating routines and procedures
   c) Seasonal start-up and shutdown
   d) Special procedures
   e) Basic troubleshooting
6) Equipment data sheets. Provide the following:
   a) Vendor and local representative's contact information
   b) Operating and nameplate data
   c) Warranty
   d) Detailed operating instructions.
   e) Tools required
   f) Types of cleaners to use
7) Maintenance program information. Provide the following:
   a) Manufacturer's installation, operation, and maintenance instructions
   b) Spare parts information
   c) Preventive maintenance actions
   d) Schedule of actions
   e) Action description
   f) History
8) Test reports document observed performance during start-up and commissioning.
9) Reference Division 01 specifications for additional requirements.

e. Shop drawings will not be accepted as satisfying the requirement for Operation and Maintenance Manuals.
f. Submittals: Provide complete copies of all reviewed submittals. Where submittals were returned "Furnish as Corrected", the contractor shall make the corrections noted by the engineer and submit final corrected shop drawings with close-out documentation.
g. Parts List: Provide an inventory of all spare parts, special tools, attic stock, etc. that have been provided to the owner.

5. Warranty Documentation: Provide all documentation and certificates related to Contractor's warranty and all other specific manufacturer's warranties indicated in the construction documents.
6. Training Verification: Provide certification that all specified training has been completed. List training session dates, times, and types. Include any session materials and recordings.
7. Inspection Certificates: Provide certificates of inspection from electrical inspector, fire marshal, and any other required special inspections.
8. Reports and System Certifications: Provide final reports and any system certifications required in other specification sections.
9. Power Riser Diagram: Provide a framed and mounted full-size copy of the overall power riser diagram (under glass) to the Owner. Also, provide three vinyl-coated copies of same. Where an existing power riser diagram is present, the Contractor shall obtain the document from the Owner, and update in digital format with the scope of this project. Edits shall be in digital format and this work shall be closely coordinated with the Owner.
10. Software and Firmware Operational Documentation: Provide documentation, including the following:
    a. Software operating and upgrade manuals.
    b. Names, versions, and website addresses for locations of installed software.
    c. Device address list.
    d. Printouts of software application and graphic screens.

11. Software Back-ups: Provide software back-ups on USB media that is clearly and permanently labeled and provided with lanyard to prevent misplacement.

1.7 MAINTENANCE MATERIAL

A. Spare Parts and Extra Stock Material

1. Parts and Materials shall be properly marked and packaged for long term storage.

B. Special Tools and Keys:

1. Provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances.
2. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, emergency generators, alarm pull boxes and panels, etc.
3. Provide at least two of any such special wrench, keys, etc. to the Owner prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Architect and Engineer.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of five years unless otherwise approved.

1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.
2. Equipment shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Installer Qualifications

1. All Electrical Contractors bidding this project must have been a licensed company for a minimum of three years to qualify to bid this project. Individual employee experience does not supersede this requirement.
2. All subcontractors bidding the electrical work must have completed one project of 70 percent this subcontract cost size and two projects of 50 percent this subcontract cost size.
3. All electrical work shall be accomplished by qualified workers competent in the area of work for which they are responsible. Untrained and incompetent workers as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any worker and unqualified or incompetent workers shall refrain from work in areas not satisfactory to them. Requests for relief of a worker shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.
4. All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician.
5. Special electrical systems, such as Fire Alarm Systems, Telecommunications or Data Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workers normally engaged or employed in these respective trades. Refer to Divisions 27 and 28 for additional requirements.

C. Licensed Professional Engineer Qualifications: Professional Engineer possessing active qualifications in accordance with Division 01 and licensed by the State in which the Work is being performed.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver or install indoor equipment until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 FIELD CONDITIONS

A. Ambient Conditions:

1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

1.11 WARRANTIES

A. Contractor Warranty: Contractor shall unconditionally guarantee all equipment, apparatus, materials, and workmanship entering into this Contract to be the best of its respective kind and shall replace all parts at their own expense, which fail or are proven defective within one year from Substantial Completion of the work by the Engineer. The effective date of completion of the work shall be the date each or any portion of the work is accepted by the Architect, Engineer, and Owner's Statement of Substantial Completion.

B. Manufacturer Warranty: Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

C. The Warranties specified herein and other Sections shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

1.12 INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole

or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

1.13 HAZARDOUS MATERIALS

A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of their work, ensure their workers are aware of this potential and what they are to do in the event of suspicion. The Contractor shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency suitable to the AHJ, and marked for intended location and application.

B. Materials used shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards, other applicable federal, state, and local laws.

C. Standard Products

1. Except where specifically noted otherwise, all equipment supplied by the Contractor shall be the standard products of a single manufacturer of known reputation and experience in the industry.
2. Only equipment, components and accessories in current production for at least five years beyond the completion date of this system shall be used and installed. Any equipment found to be obsolete or not in future production will be removed and replaced at Contractor's expense. This includes all equipment, materials and labor.
3. Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.

D. Product numbers are subject to change by the manufacturer without notification. In the event a product number is invalid or conflicts with the written description, notify the Engineer in writing prior to ordering the material and performing installation work.

2.2 PRODUCT SUBSTITUTIONS

A. Conform to the substitutions requirements and procedures outlined in Division 01.

B. One substitution for each product specified will be considered and substitutions must be submitted to Engineer a minimum of 10 days prior to bid using the standard CSI substitution request form.

C. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.

D. Where products are noted as "or equal", a product of equivalent design, manufacture, and performance will be considered. Submit product data (product information, catalog cut sheets, test data, etc.) to substantiate that the product is in fact equivalent to that specified. The burden of proof that the substituted product is equivalent to the specified product rests with the Contractor. Whenever material, process or equipment is specified in accordance with an industry specification (ANSI, TIA, etc), UL rating, or other association standard, present an affidavit from the manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, submit supporting test data to substantiate compliance.

E. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the contract documents are used to establish standards of quality, utility and appearance and shall not be construed as limiting competition. Materials, processes or equipment that, in the opinion of the Engineer, are equivalent in quality, utility and appearance will be approved as substitutions to that specified when “or equal” follows the manufacturers' names or model number(s).

F. When the Engineer accepts a substitution in writing, it is with the understanding that the Contractor guarantees the substituted product, component, article, or material to be equivalent to the one specified and dimensioned to fit within the construction according to contract documents. Do not provide substituted material, processes, or equipment without written authorization from the Engineer. Assumptions on the acceptability of a proposed substitution, prior to acceptance by the Engineer, are at the sole risk of the Contractor.

G. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the work, or from provisions of the specifications.

H. Contractor shall pay expenses, without additional charge to the Owner, in connection with substitution materials, processes and equipment, including the effect of substitution on their work or other Contractor's work.

I. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall advise all such Contractors of the change and shall reimburse them for all necessary changes in their work. Any Drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Review of Shop Drawings by the Engineer does not absolve the Contractor of this responsibility.

J. Contractor shall be responsible and assume all costs for removal and replacement of any substituted product installed without prior written approval. Such costs shall include, but not be limited to labor, materials as well as any penalties, fees or costs incurred for late completion.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Supervision of Work: Each Contractor and Sub-Contractors shall personally supervise the work or have a competent superintendent on the project site at all times during progress of the work, with full authority to act in matters related to the project.

B. Conduct of Workmen: The Contractor shall be responsible for the conduct of all workmen under their supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden. Possession of a fire-arm is prohibited and may result in prosecution. Foul or bad language, graffiti is strictly prohibited.

C. No tobacco use, including smokeless tobacco, is allowed on property.

3.2 EXAMINATION

A. Each Contractor shall inform themself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. All Contractors shall carefully examine all Drawings and Specifications and inform themselves of the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of their work.

B. Each Contractor shall fully acquaint themself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in their work all expenses or disbursements in connection with such matters and conditions. Each Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

3.3 PREPARATION

A. Surveys, Measurements, and Grades

1. The Contractor shall lay out their work and be responsible for all necessary lines, levels, elevations and measurements. They must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from their failure to do so.
2. Base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

3. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, they shall notify the Engineer through normal channels of job communication and shall not proceed with his work until they have received instructions from the Engineer.

3.4 INSTALLATION

A. At no time shall the contractor work on energized electrical equipment. Contractor shall comply with NFPA 70E requirements at all times throughout construction.

B. Permits and Fees

1. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, and other costs in connection with their work. As necessary, the Contractor shall file all required plans, utility easement requests and drawings, survey information on line locations, load calculations, etc., prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all required certificates of inspection for their work and deliver same to the Engineer before request for final acceptance and final payment for the work.
2. Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.

C. Codes and Regulations

1. The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus or drawings required in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on drawings and/or specified.
2. All materials furnished and all work installed shall comply with the adopted edition of the National Electrical Codes, National Fire Codes of the National Fire Protection Association, the requirements of local utility companies, and with the requirements of all governmental agencies or departments having jurisdiction.
3. All electrical work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the AHJ, as applicable or required. Electrical work shall not commence until such plans are in the hands of the Electrical Contractor.
4. The Contractor shall insure their work is accomplished in accord with OSHA Standards and any other applicable government requirements.
5. Where conflict arises between any code and the contract documents, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at their own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

D. Materials and Workmanship

1. All electrical equipment, materials and articles incorporated in the work shall be new and of equal quality to the specified basis of design. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades.
2. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed

so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).

3. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein.
4. All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.
5. Comply with National Electrical Contractors Association (NECA) performance standards that are published as National Electrical Installation Standards (NEIS).
6. All applicable equipment and devices provided shall meet all FCC requirements and restrictions.

E. Weatherproofing

1. Where any work penetrates waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.
2. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

F. Equipment Access

1. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of their work. Cooperate with the Prime Contractor and all other Contractors whose work is in the same space, and advise each Contractor of equipment requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.
2. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.
3. Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work. In the absence of such specifications, at a minimum such work shall comply with the specifications below. All locations for access panels which are not specifically indicated on the drawings shall be submitted to and approved by the architect prior to ordering.
4. Access Doors; in Ceilings or Walls:
    a. In mechanical, electrical and service spaces: 14-gauge aluminum brushed satin finish, 1" border.
    b. In finished areas: 14-gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.
    c. In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.

G. Connections

1. Provide rough-in and final connections to all electrically operated equipment furnished under the Work of the contract documents. Carefully coordinate with equipment suppliers,

manufacturer's representatives, vendors, and other trades to provide complete electrical and dimensional interface to all equipment.

2. Provide all power wiring complete from power source to motor or equipment junction box, including power wiring through starters or contactors. Install all starters not factory mounted on equipment.
3. Provide all control, interlock, sensor, thermocouple and other connections required for equipment operation. Coordinate ampacity and voltage characteristics for all motors and equipment.
4. Prior to bidding the work, coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other trades, to ensure all needed wiring is provided. Failure to provide such coordination shall not be justification for claims of extra compensation of a time extension to the Contract.
5. At no times shall the contractor work on energized electrical equipment. Comply with NFPA 70E requirements at all times during construction.

H. Scaffolding, Rigging, and Hoisting: The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

3.5 RESTORATION

A. The Contractor shall replace to their original condition all paving, curbing surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item to be replaced. All repairs shall be to the satisfaction of the Engineer, and in accord with the Architect's standards for such work, as applicable. Patchwork on new construction will not be accepted.

3.6 IDENTIFICATION AND OPERATING INSTRUCTIONS

A. Provide all equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

B. Provide operating instructions for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
3. Safety precautions.
4. The procedure in the event of equipment failure.
5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

C. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

3.7 SYSTEM TESTING, VERIFICATION, AND START-UP

A. The Contractor (and Sub-Contractors) shall be responsible for starting-up, testing, checking, examining, inspecting, and verifying their systems.

B. The Electrical Contractor shall designate an individual under their employment to lead the start-up, testing and verification process. This person should not be the project manager or job site superintendent, but a person dedicated to making this critical task successful and completed in a timely manner.

C. A pre-start-up conference shall be held with the Architect, Owner, Contractors, and the Manufacturer providing startup services. The purpose of this meeting will be to discuss the goals, procedures, etc. for start-up.

D. The Contractor shall include in the bid to provide systems startup and verification for all electrical systems specified for this project. Specific startup, testing, and verification requirements are included throughout the Electrical specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians (unless noted otherwise) and shall complete and submit start-up reports/checklists. Submit start-up reports to the Engineer. The Contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner.

E. Where manufacturer start-up is not specified for a particular piece of equipment or system, the Contractor shall be responsible to perform start-up in strict accordance with manufacturer's instructions.

F. The Contractor shall be responsible for completion of a System Verification Checklist (SVC) / Manufacturer's Checklists. Furnish to the Testing Agent and Engineer. Sample checklists shall be submitted to the Engineer, Owner, and Testing Agent for approval.

G. The completed reports shall be organized and bound together in a tabbed binder and submitted for review and approval.

3.8 FIELD QUALITY CONTROL

A. Inspections

1. Before requesting a final review of the installation from the Architect and/or Engineer, the Contractor shall thoroughly inspect the installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.
2. Owner's and Engineer's inspections: Two inspections will be held to generate and then review punchlist items. All site inspections and visits thereafter shall be billed to the Contractor at the Engineer's standard hourly rates.
3. The Contractor shall provide as a part of this contract electrical inspection by a competent Electrical Inspection Agency, licensed to provide such services. The name of this agency shall be included in the list of materials of the Form of Proposal by the Contractor. All costs incidental to the provision of electrical inspections shall be borne by the Electrical Contractor.
4. The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when they anticipate commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so

inspected. Costs associated with any rework, cutting, and patching will be at the expense of the responsible Contractor.

5. Inspections shall be scheduled for rough-in as well as finished work. The rough inspections shall be divided into as many inspections as may be necessary to correct deficiencies. Report of each such inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.
6. Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.
7. Before final acceptance, the Contractor shall furnish three copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

B. Punch Lists

1. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least three stages of the project.
   a. For review of in-wall work that will be concealed by drywall or other materials well before substantial completion.
   b. For review of the above-ceiling work that will be concealed by tile or other materials well before substantial completion.
   c. For review of all other work as the project nears substantial completion.
2. When all work from the Contractor's punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing two weeks prior to the proposed date.
3. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review.
4. At the engineer's option, the contractor shall supply digital photographs via email or file-share of any installed work.
5. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due 10 days from date of each additional visit) at a rate of $125.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.
6. All panelboard fronts shall be removed prior to final punch list inspection and re-installed after completion. Directories for each panelboard shall be completed and available for review by the Engineer at that time.

C. Non-Conforming Work

D. Manufacturer Services

3.9 CLEANING

A. The Contractor shall, at all times, keep the area of work presentable to the public and clean of rubbish caused by their operations; and at the completion of the work, shall remove all rubbish, all tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the Contractor does not attend to such cleaning immediately upon request, the Engineer may cause cleaning to be done by others and charge

the cost of same to the responsible Contractor. Each Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of rubbish or debris.

B. After completion of all work and before final acceptance of the work, each Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of materials, equipment and all associated fabrication. Pay particular attention to finished area surfaces such as lighting fixture lenses, lamps, reflectors, panels, etc.

3.10 TRAINING

A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating all systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or their representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, Architect and Engineer in advance of this period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

B. Training shall be accompanied by complete as-built documentation and the technical systems operation manual.

C. The training shall be accomplished by a factory trained representative. Include a minimum of Four hours for each system described here-in unless noted otherwise. Each equipment representative shall be represented wherever their equipment is used.

D. Demonstration and Training DVDs: These training sessions shall be videotaped by the Installer. Submit two copies within seven days of end of each training module. On each copy, provide an applied label with the following information:

1. Name of Project.
2. Name and address of photographer.
3. Name of Architect and Construction Manager.
4. Name of Contractor.
5. Date video was recorded.

E. Brochures: Furnish Owner a complete set of operating instructions and diagrams.

F. Instruction Program: Submit outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

G. At completion of training, submit two complete training manual(s) for Owner's use.

H. Qualification Data: For facilitator, instructor and photographer.

I. Attendance Record: For each training module, submit list of participants and length of instruction time.

3.11 PROTECTION

A. The Contractor shall be entirely responsible for all material and equipment furnished for their work and special care shall be taken to properly protect all parts thereof from damage during the

construction period. Such protection shall be by a means acceptable to the Engineer. Equipment damaged while stored on site either before or after installation shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor. Electrical equipment exposed to the weather shall be replaced by the Contractor at their own expense.

END OF SECTION

SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Slotted Support Systems.
2. Conduit and Cable Supports.
3. Mounting, Anchoring, and Attachment Components.
4. Fabricated Metal Supports.
5. Concrete Bases.
6. Vibration Isolation pads.
7. Sleeves for penetration of non-fire-rated construction walls and floors.
8. Sleeve-seal systems.
9. Firestopping.
10. Cutting and Patching
11. Painting

1.3 REFERENCES

A. Abbreviations and Acronyms

1. EMT: Electrical Metallic Tubing.
2. FMC: Flexible Metal Conduit.
3. GRC/GRS: Galvanized Rigid Steel Conduit.
4. LFMC: Liquid-tight flexible metal conduit.
5. RMC: Rigid Metal Conduit

B. Definitions

1. Channel: A continuous slotted channel (strut) with inturned lips suitable for assembly into multiple configurations

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. Metal Framing Manufacturers Association (MFMA)
   a. MFMA-4: Metal Framing Standards Publication
   b. MFMA-103: Guidelines for the use of Metal Framing

1.4 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations with Division 07 Section "Roof Accessories."

1.5 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of components, profiles, and finishes.
2. Include rated capacities.

B. Shop Drawings: For fabrication and installation details and include calculations for the following:

1. Slotted channel systems.
2. Equipment supports.
3. Concrete Bases for Equipment.
4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: Signed and sealed by a qualified professional engineer. For field assembled or fabricated hangers and supports for electrical systems.

1. Include design calculations and details of trapeze hangers.

D. Qualification Data: For professional engineer.

1.6 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to the authority having jurisdiction, and marked for intended location and application.

B. Delegated Design: Design support systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 SLOTTED SUPPORT SYSTEMS

A. Description: Preformed, continuous slot, bolted channels with associated fittings and hardware.

1. Available Manufacturers: Subject to compliance with requirements, provide products from one of the following or an approved equal:
    a. Eaton B-Line.
    b. Kindorf.
    c. nVent Caddy.
    d. Power-Strut.
    e. SuperStrut.
    f. Unistrut.
2. Comply with MFMA-4 for factory fabricated components suitable for field assembly.
3. Material and Finish for channel, fittings, and accessories:
    a. Steel: Minimum 16 gauge, Hot-dip galvanized after fabrication and applied according to ASTM A123 or A153 suitable for indoor or outdoor wet locations.
    b. Stainless Steel (type 316) per ASTM A276 suitable for corrosive environments.
    c. Fiberglass: UV-resistant, fire retardant, fiberglass-reinforced polyester resin suitable for corrosive environments.
4. Channel Dimensions: Minimum 1-5/8 inches wide with varying heights and welded combinations selected to meet applicable load criteria.

2.3 CONDUIT AND CABLE SUPPORTS

A. Available Manufacturers: Subject to compliance with requirements, provide products from one of the following or an approved equal:
    1. Eaton B-Line
    2. nVent Caddy
    3. Thomas & Betts

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Provide plugs with number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported.

D. Device Box Mounting Brackets: Factory-fabricated sheet steel brackets for support of device boxes adjacent to or between studs.

E. Through-Stud Cable and Raceway Support Clips: Factory-fabricated spring steel clip for cables or raceways where run horizontally through metal studs.

F. Roof-mounted Raceway Support Blocking: Non-penetrating, factory-fabricated support blocking for use under roof-mounted raceways. Wedge-shaped blocking constructed of 100% recycled UV-resistant Rubber with integral galvanized steel strut to accept raceway support clips.

G. Tee Bar Grid Box Hanger: Factory-fabricated metal electrical box hanger for supporting boxes at locations between ceiling system t-grid components. Height adjustable for various electrical box depths. Attached to ceiling tee bar with screws or integral clamp for stability. Includes tab for independent support wire attachment.

2.4 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS

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

1. Eaton B-Line
2. Empire Industries.
3. Hilti.
4. ITW.
5. MKT Fastening.

B. Description: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, or steel with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
3. Concrete Inserts: Steel, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Solid, threaded steel.

2.5 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

2.6 VIBRATION ISOLATION PADS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Korfund Maxi-Flex Pads or a comparable product by one of the following:

1. Ace Mountings Co.
2. California Dynamics Corporation.
3. Eaton B-Line.
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibration Eliminator Co.
7. VMC Group

B. Description: Molded, oil resistant, non-skid elastomeric pads arranged in 2-inch square segments.

C. Size: Factory or field cut to match requirements of supported equipment.

D. Load Rating from 120 lbs. up to 360 lbs. per 2-inch segment.

2.7 SLEEVES

A. Wall and Floor Sleeves:

1. Galvanized Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

2.8 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable. Link Seal system or approved equal.

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Glass reinforced nylon polymer.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.9 FIRESTOPPING FOR ELECTRICAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products from one of the following or approved equal:

1. Hilti
2. Specified Technologies Inc (STI)
3. Wiremold

B. Source Limitations: Obtain firestopping systems through one source from a single manufacturer.

C. General Requirements:

1. Firestopping systems shall bear UL classification marking corresponding to its Fire Resistance Directory.
2. Comply with testing requirements set forth in ASTM E814 or UL 1479.
3. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
4. Provide components for each through-penetration firestop system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

D. Fire rated cable pathways: Re-penetrable, maintenance-free cable management devices for use with cable bundles penetrating through fire rated walls or floors.

1. Shall contain a built-in fire sealing system sufficient to maintain the hourly rating of the fire rated wall or floor being penetrated.
2. The system shall adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or reinstall firestop materials.
3. Shall be engineered to allow two or more devices to be ganged together with wall plates for larger cable capacities.

E. Fire-rated cable grommets: Molded, two-piece grommet with sealing membrane for use with single cables or small bundles at through or membrane wall penetrations.

1. System shall be installed around cables and shall lock tightly into the wall assembly.

F. Outlet Box Putty Pads: Non-hardening, moldable, intumescent material shaped into preformed pads for use with metallic outlet boxes.

G. Refer to Division 07 for requirements related to other firestopping systems and materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with manufacturer's installation requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CUTTING AND PATCHING

A. Unless otherwise indicated, provide cutting and patching necessary to install the work specified. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accordance with the Architect's standards for such work.

B. Do not cut structural elements without reinforcing the structure to maintain the designed weight bearing and stiffness. Coordinate approved reinforcement method with Architect and Structural Engineer.

3.3 SUPPORT SYSTEM APPLICATION

A. Comply with NFPA 70, NECA 1, NECA 101, and MFMA-103 for application of hangers and supports for electrical equipment and systems except where requirements of this Section are more stringent.

B. Maximum Horizontal and Vertical Support Spacing for Raceway(s): Space supports for raceways as required by NFPA 70.

C. Minimum Hanger Rod Size for Raceway Supports: 3/8-inch diameter unless noted otherwise.

D. Single Raceways:

1. For Raceways 1-1/4-inch and smaller: Install adjustable steel band hanger suspended on threaded rod.
2. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/4-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

E. Multiple Raceways and single raceways larger than 1-1/4-inch:

1. Install trapeze-type supports fabricated with slotted support system suspended on threaded rods for horizontal applications and fastened to building structure for vertical applications.
2. Size so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
3. Secure raceways and cables to these supports with two-bolt steel conduit clamps or single-bolt steel conduit clamps using spring friction action for retention in support channel.

3.4 SUPPORT SYSTEM INSTALLATION

A. Comply with NFPA 70, NECA 1, NECA 101, and MFMA-103 for installation requirements except where requirements of this Article are more stringent.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components multiplied by a safety factor of four with a minimum of 200 lbs.

C. Mounting and Anchorage of Surface-Mounted or Recessed-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
    a. Where support anchors are required, establish their type and locate in concrete construction before concrete is poured. Fit each hanger rod with a nut at its upper end, and set nut in a universal concrete insert in the form. Where supported weight exceeds holding strength of a single insert, pass rods through top slot of inserts and interlock with reinforcing steel. Also, where particularly heavy loads are to be supported, suspend hanger rod or rods from a structural angle spanning two or more inserts and securely bolted thereto to distribute the weight.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Self-drilling concrete anchors or expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. For Surface-Mounted Items on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to structure. Attachment to gypsum wall board is not acceptable as sole support means; slotted-channel rack solidly attached to structure or light-gauge metal framing at both ends is required.
8. For Recessed-Mounted Items in Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices to intermediate light-gauge metal framing members on each side of device or provide slotted-channel racks within hollow wall attached to structure by means that meet anchorage requirements. Attachment to gypsum wall board is not acceptable as sole support means.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars or existing raceways embedded in slab. Verify reinforcing locations with Structural Engineer and X-Ray existing concrete structures as required.

E. Do not support any items (equipment, piping, conduit, etc.) exceeding 2 inches in diameter from the bottom of slabs. Where intermediate supports are required between structural members, use

slotted steel channels support systems attached to beams or joists in order to avoid attachment to slabs.

F. Slotted Support Systems

1. Install slotted channel systems level and plumb.
2. Remove burrs from all exposed cut edges prior to installation.

G. Wall Stud and Ceiling Supports

1. Fasten junction, pull and devices boxes securely to the building construction, independent of raceway system.
2. Install Device Box Mounting Brackets supported between two studs. Attach all device boxes to two studs, device box stabilizers are prohibited.
3. Install Tee Bar Grid Box Hanger supported between two ceiling grid tee bars where devices boxes are located flush in recessed suspended ceilings. Install at least one independent support rod from box hanger to structure.
4. Install Through-Stud Cable and Raceway Support Clips where cables or raceways run horizontally through metal studs.

H. Install Roof-mounted Raceway Support Blocking where raceways run on across roofing.

1. Coordinate installation of roof supports with items specified in Division 07 Section "Roof Accessories." Provide products compatible with rooftop materials included in the Work to maintain warranty of roof system.

I. Threaded Rod Hardware

1. Provide minimum of two lock nuts per threaded support rod except where lock nut tightens against a threaded socket, one locknut may be used.
2. Trim rod excess to within 1-inch of locknut, de-burr, and provide protective endcap.

J. Support raceways at a distance above suspended ceilings to permit removal of ceiling panels and luminaires.

K. Locate raceways and supports so as not to hinder function or code required clearance to any system or equipment.

L. Provide independent supports and hang all electrical raceways and devices from the building structure with UL listed and approved materials. Utilizing the support systems of other trade's work is prohibited, except with written approval from the Engineer.

M. Provide riser support clamps for vertical conduit runs and install at each floor level penetration and at additional locations required to support weight of system.

N. Tighten all bolted connections to proper torque values in accordance with manufacturer's written instructions.

O. Provide supports to maintain 1/4-inch air space between raceway and mounting surface where raceways are mounted exposed in wet or corrosive locations and where directly attached to concrete or masonry.

P. The use of tie wire or perforated metal tape for support or fastening of any raceway system is prohibited.

Q. Where galvanized wire is used for cable supports above suspended ceilings, provide minimum #12 support wire independent of ceiling system secured at both ends. Paint or provide tag to distinguish supports from ceiling system.

R. Welding directly on raceways, fittings, or outlet boxes is prohibited.

3.5 INSTALLATION OF VIBRATION ISOLATION PADS

A. Select vibration device load ratings to match equipment loading and deflection criteria.

B. Arrange pads in single or multiple layers of sufficient stiffness for uniform loading.

C. Install pre-cut segments in accordance with manufacturer recommendations to match shape of equipment base.

3.6 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.7 CONCRETE EQUIPMENT BASES

A. Housekeeping Pads: Construct concrete housekeeping pads a minimum of 4-inches thick and 6-inches larger in both directions than supported unit.

B. Exterior Equipment Pads: Construct exterior equipment pads a minimum of 8-inches thick and 6-inches larger in both directions than supported unit unless noted otherwise.

C. Use 3000-psi, 28-day compressive-strength concrete unless otherwise noted. Comply with Division 03 Section "Cast-in-Place Concrete" and ACI standards for subbase requirements, concrete materials, reinforcement, placement, and cover requirements.

1. Reinforce pads with a minimum #4 rebar on 12-inch centers each way or equivalent welded wire fabric. Support reinforcement and tie together to prevent displacement during construction.
2. For interior pads, provide #4 dowels at 24-inch centers each way (minimum of 4) to anchor to structural slab below. Embed dowels into slab a minimum of 3-inches.
3. Provide rubbed finish for all surfaces.
4. Provide ¾-inch chamfer at all exposed edges.
5. Provide Engineer approved repairs if pad surface is rough or shows signs of honeycomb.
6. Provide crown for exterior pads with a slope of 1/8-inch per foot.
7. Do not set heavy equipment on pad for at least 7 days after pour unless approved by Engineer.

D. Anchor equipment to concrete base.

1. Locate anchors to be a minimum of 10 bolt diameters from edge of the base.

2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.
4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.8 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Coordinate all required openings and provide sleeves and inserts prior to construction of wall and floor systems. Where openings are missed or incorrectly located, provide core-drilling and patching at no additional expense to owner.

C. Install sleeves without compromising structural integrity of wall or floor.

D. Sleeves for Conduits or Cable Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
    b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
2. Unless sleeve seal systems are used, size pipe sleeves to provide a minimum 1/4-inch annular clear space between sleeve and raceway. Where conduit motion due to expansion and contraction will occur, provide sleeves a minimum of two conduit sizes larger than the nominal conduit diameter.
3. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls.
    a. For conduit penetrations, cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
    b. For cable penetrations, extend sleeve a minimum of 2-inches beyond surface of wall and provide plastic insulated bushing.
4. Install sleeves for floor penetrations. Extend sleeves installed in floors a minimum of 6-inches above finished floor level unless noted otherwise. Install sleeves during erection of floors.
5. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.

E. Sleeves for Cables Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound or acoustical sealant for gypsum board assemblies.

F. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units and counter flashing applied in coordination with roofing work. Coordinate all work with roofing system to maintain roof warranty.

G. Exterior-Wall and Floor Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal system. Size sleeves to allow for manufacturer recommended annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Where sleeves are installed in core drilled openings, grout sleeve into the opening.

H. Where sleeves are installed exposed in finished spaces, provide metal escutcheon plates of size to match the sleeve.

I. Sleeve-Seal-System:

1. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
2. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.9 ELECTRICAL SYSTEM FIRESTOPPING INSTALLATION

A. Install firestopping at all penetrations of fire-rated assemblies. Comply with requirements in Division 07 and as outlined below.

B. Coordinate location and proper selection of firestop devices with fire rated assembly. Ensure cast-in place devices are installed before placement of concrete.

C. Install firestop materials in accordance with UL Fire Resistance Directory and manufacturer's instructions.

D. Affix permanent label to each side of penetration immediately adjacent to firestopping to communicate to futures installers and code authorities the following:
1. Fire-stop product/system used
2. Installation Company
3. Penetration Hour Rating
4. Installation Date

E. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas. Keep areas of work accessible until inspection by applicable code authorities.

3.10 PAINTING

A. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wire and cable rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Control Voltage Conductors and Cables

B. Related Requirements:

1. Refer to Division 27 for requirements related to balanced unshielded twisted pair (UTP) cabling.

1.3 REFERENCES

A. Abbreviations

1. RoHS: Restriction of Hazardous Substances.

B. Definitions

1. Low Voltage: Circuits and equipment operating at more than 50VAC but less than 1000VAC for building electrical distribution systems.
2. Control Voltage: Circuits and equipment operating at less than 50VAC for remote-control and signaling power-limited circuits.
3. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
4. Homerun: The run of raceway(s) and cable(s) between the panelboard or switchboard and the junction box in the area served where branch circuit cables originate.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. National Electrical Contractors Association (NECA)

a. NECA 104, "Installing Aluminum Building Wire and Cable"
b. NECA/NACMA 120, "Standard for Installing Armored Cable (Type AC) and Type Metal-Clad (MC) Cable"

1.4 SUBMITTALS

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

B. Product Schedule: Indicate type, use, and location.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

2.2 BUILDING WIRE AND CABLE

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

1. Alpha Wire Company.
2. Cerro Wire LLC.
3. Encore Wire Corporation.
4. General Cable Technologies Corporation.
5. Okonite Compony.
6. Southwire Company.

B. Building Wire Description: Flexible, insulated and uninsulated, drawn current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

C. Cable Description: A factory assembly of one or more current-carrying insulated conductors in an overall protective sheath.

D. General Requirements:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

E. Copper Conductors: 98% conductive annealed copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Conductor Insulation:

1. 600V, 90°C
2. Comply with ANSI/NEMA WC 70/ICEA S-95-658.
3. THHN/THWN-2: Comply with UL 83.
4. XHHW-2: Comply with UL 44.
5. RHW-2: Comply with UL 44 and UL 2196.

G. Metal Clad Cable, Type MC

1. Comply with UL1569.
2. Circuits: Single circuit with color coded current carrying conductors and insulated ground conductor.
3. Conductor Insulation: THHN/THWN-2.
4. Armor Jacket: Aluminum Interlocking.
5. Listed for use in through penetration firestop systems.
6. Where applicable, integral 16AWG solid TFN (purple/grey) control conductors suitable for 0-10V dimming.
7. Type HCF: rated for healthcare use with grounded green exterior sheath.

2.3 SPLICING DEVICES & CONNECTORS

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

1. 3M; Electrical Products Division.
2. AFC Cable Systems, Inc.
3. Burndy
4. Gardner Bender.
5. Hubbell Power Systems, Inc.
6. Ideal Industries, Inc.
7. ILSCO.
8. NSi Industries LLC.
9. O-Z/Gedney;
10. Thomas & Betts.
11. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Material: Tin plated copper

D. Twist-On Wire Connectors: spring pressure type, 600V, 105°C insulation, capable of connecting two or more wires up to #8 AWG in a pigtail application.

E. Crimp Sleeve Splices: butt or parallel crimp type, copper sleeve with nylon cover and skirted insulators, capable of permanent connection of two or more wires up to #10 AWG.

F. Compression Splices: standard or long barrel type, 90°C, with cold shrink tubing, for use with hydraulic crimping tool, capable of permanent connection of wires #6 AWG and larger.

G. Ring or Flanged Fork Tongue Terminals: crimp type, 600V, 105°C insulation, insulated serrated barrel, capable of terminating wires up to #10 AWG.

H. No aluminum splicing devices or connectors are permitted.

2.4 CONTROL VOLTAGE CONDUCTORS AND CABLE

A. Control Cable: NFPA 70, Type CMG or CMP

1. Single or Multi-pair, twisted, minimum No. 18 AWG, stranded tinned copper conductors.
2. PVC insulation.

3. Shielded or Unshielded.
4. Flame Resistance:
   a. CMG: Comply with UL1685
   b. CMP: Comply with NFPA 262

B. Class 1, 2, and 3 Control Circuits: Stranded Copper, Type THHN/THWN-2

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATION

A. Feeders and Branch Circuits: Copper. THHN/THWN-2. Solid for #10 AWG and smaller; stranded for # 8 AWG and larger.

1. Provide XHHW-2 insulation for the following:
   a. Circuits routed exposed on rooftops.
   b. Conductors on the load side of a Variable Frequency Drive.

B. Conductors for motors or vibrating or oscillating equipment: Extra flexible stranded.

C. Cord Drops and Portable Appliance Connections: Type SOOW, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

D. Conductor sizes indicated on drawings are based upon 75 degree C rating.

E. Minimum branch circuit or feeder size:
1. Not less than #12 AWG copper wire unless noted otherwise.

F. Minimum control circuit conductor sizes:
1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG

G. Provide all wire for the project in new and undamaged condition. Deliver in standard coils or reels. Wires and cables manufactured more than 24 months prior to date of delivery to the site are not acceptable.

3.2 EXAMINATION

A. Prior to installing conductors and cables:

1. Verify that raceway installation is complete according to Section 260533 "Raceways and Boxes for Electrical Systems" and ready for installation of conductors and cables.
2. Verify that raceways are properly sized in accordance with NEC.
3. Visually inspect exposed raceways to ensure that raceways are not damaged and bends are not deformed.
4. Verify that raceways do not exceed the maximum number of bends between pull-points.
5. Verify raceways have been cleaned of all dirt and debris.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Pulling Conductors in Raceways

1. Pull cables in accordance with cable manufacturer and pulling equipment manufacturer recommendations as well as applicable sections of the National Electric Code.
2. Use installation equipment, tools, and materials as necessary, such as sheaves, pulling eyes, basket grips, winches, cable reels and/or cable reel jacks, duct entrance funnels, and pulling tension gauges, and approved pulling lubricants where required to facilitate cable pulling without damage to cables or raceway.
3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not use lubricants that harden or become adhesive with age. Apply lubricant where cables enter ducts and conduits and at all intermediate access points on long or difficult pulls.
4. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Utilize special remote readout equipment to ensure compliance.
5. Avoid abrasion and other damage to cables during installation. Provide physical protection of cables, such as using appropriately sized flexible cable guides or feed-in tubes, at the entrance of boxes and raceways.
6. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

B. Bend Radius

1. Handle conductors and cables carefully. Make bends in cables and conductors such that cables, conductors, sheaths, armor, etc., are not damaged.
2. Do not bend conductors and cables to less than the NEC and manufacturer recommended minimum bending radius.
3. Ensure that tools and accessories used to install conductors and cables, such as rollers, sheaves, trolley assemblies, tube guides, and/or raceways, are properly sized and utilized to be greater than the minimum bending radii of conductors and cables.
4. Minimize bending where conductors and cables enter or exit raceways, cabinets, and boxes. Do not install cables that have been bent or kinked to a radius less than the recommended dimension.
5. Install conductors only after insulating bushings are in place.

C. If multiple circuits are pulled in a single homerun, provide a dedicated neutral for each phase conductor. In these cases, a maximum of seven conductors (six current carrying and one ground) are permitted in a single conduit except for switch legs and travelers in multi-point switching arrangements. De-rate conductors per NEC.

D. Multi-wire branch circuits with a shared neutral are not permitted unless specifically noted on the drawings. Where indicated, group the phases and neutral together with cable ties in the panelboard and in all pull boxes.

E. Install conductors for isolated power systems in as short a run of conduit as practicable. The use of pulling compound or lubricant is not permitted on conductors in isolated power systems.

F. Voltage Drop:

1. Adjust conductors and conduit sizes accordingly based on actual field installed conditions.
2. Size and Install all feeders and branch circuits for a maximum 2% voltage drop in feeders and 3% in branch circuits with a maximum total voltage drop of 5%.
3. Calculate using a load equal to 80% of the supply breaker rating unless the circuit breaker is rated to carry 100% of the load.
4. Where the conductor length from the panel to the first outlet on a circuit exceeds the values below, adjust branch circuit conductors from the panel to the first outlet. Increase the conductor size of remaining branch circuit as needed to meet above voltage drop limitations.
   a. For 277VAC homeruns exceeding 125-feet, #10 AWG minimum

b. For 120VAC homeruns exceeding 50-feet, #10 AWG minimum
c. For 120VAC homeruns exceeding 100-feet, #8 AWG minimum

G. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

H. Install cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours.

I. Bundle cables where run in groups using listed supports. Provide independent supports directly from structure, do not route through structure or on work of other trades.

J. Metal Clad Cable, Type MC

1. The use of metal clad cable is not permitted, except for connections to ceiling mounted recessed and semi-recessed luminaires concealed in accessible ceiling where the maximum length is limited to 72-inches.
2. MC cable is permitted for the following applications:
   a. Normal power branch circuits between wiring devices and nearest junction box, #10 and smaller, where concealed in walls and ceilings.
      1) Provide no more than three MC cable circuit connections per junction box.
      2) For lighting circuits, limit length of MC cable to 6ft from the junction box to the first luminaire and extend MC cable to other fixtures in the same room.
3. MC cable is not permitted for the following:
   a. Emergency or standby power circuits
   b. Feeders
   c. Homeruns to panelboards.
   d. Power Branch Circuits
   e. Branch circuits with conductors larger than #10 AWG.
   f. Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
   g. Within mechanical, electrical or telecommunication equipment rooms.
   h. Exposed locations.
   i. Inaccessible ceiling locations.
   j. Within masonry walls.
   k. Exterior or outdoor locations.
   l. Wet or damp locations.
   m. Direct buried locations.
4. Where MC cable is permitted, comply with the following:
   a. Install MC cables and connectors in accordance with NECA/NACMA 120.
   b. Use only for single-circuit applications. For devices in the same wall connected to different circuits, install separate single circuit cable for each circuit.
   c. Support MC cables with clamps, clips, or similar product specifically designed for supporting cables in accordance with NEC and route all runs parallel or perpendicular to building lines with right angle turns complying with manufacturer's bend radius requirements.
   d. Cables shall be bundled where run in groups using listed supports to maintain proper spacing. Where spacing can't be maintained, apply adjustment factors for derating conductors.
   e. Do not route through structure or on work of other trades. Provide independent supports directly from structure.

K. Control Circuit Conductors and Cables

1. Use insulated spade lugs for wire and cable connection to screw terminals.
2. Conductors installed within environmental air plenums shall be per NEC. Article 800 and other applicable codes, with FEP-type insulation or an approved equivalent. Provide

plenum-rated cable supports where plastic straps or other supports, etc., are installed in plenum areas.

3. Where indicated, systems and control conductors that are installed exposed shall not be routed across ceilings or ductwork. Provide independent supports anchored to building structure or other permanent support members.
4. Install in such a manner as to not interfere with the access to or operation of equipment or removal of ceiling tiles.
5. Nylon tie-wraps shall be installed in such a manner so as to bundle conductors neatly, allowing runouts of single conductors or groups to drop down to equipment served.
6. Install grommets where dropping out of trays or into panels or service columns.
7. Install sleeves with bushings where penetrating partitions.
8. Provide firestopping for penetrations of fire rated assemblies with approved materials.

3.4 SPLICES, TAPS, CONNECTIONS, AND TERMINATIONS

A. Prepare cable in accordance with the conductor, cable, splice and termination component manufacturers' recommendations and instructions.

B. Cut conductors and cables using tools and methods which ensure a square cut. Do not nick or damage conductors.

C. Ensure conductor inserts fully into the connector or termination with the insulation fitting closely to the connector or termination.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, a calibrated torque tools shall be used to achieve that indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

E. Splices and Taps

1. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
2. Make splices and taps in junction boxes or other enclosure approved for the wiring method.
3. For conductors #10 AWG and smaller conductors, use pressure crimp type connections.
4. For conductors #8 AWG and larger, use a hydraulic compression type connection, with cold shrink tubing and tape to restore full insulation value of the wire being spliced.

F. Connections and Terminations

1. Ensure that conductor temperature and ampacity ratings are compatible with connectors, terminals, and equipment to which they are to be connected.
2. Provide crimp-applied ring or flanged fork type terminals for motor and equipment terminals where such terminals are provided on motor and equipment leads or on all stranded wire terminations using #10 AWG or smaller conductors.
3. Motor Connections shall use connection lugs with motor stub splice insulators.

G. Wiring at Outlets: Install conductors at each outlet with at least 12 inches of slack.

H. All cables and wiring, regardless of voltage, installed in manholes or cable vaults shall be routed in such a manner to provide a minimum of 10 feet of slack cable for future splicing. Install cables along walls by utilizing the longer route from entry to exit. If both routes are symmetrical,

provide a loop of cable secured to wall. All cables shall be tied to insulated cable supports on wall-mounted racks, spaced a maximum of three feet apart.

3.5 PROTECTION

A. Intentional or unintentional painting of exposed low-voltage and/or control-voltage cabling insulation is prohibited. Ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades.

B. Review the project's painting requirements for all disciplines and provide protection as required.

C. Where exposed cabling is being installed in exposed ceiling or wall spaces that are required to be painted, provide cabling in enclosed raceways or provide alternate options for cable colors to engineer for approval.

3.6 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

1. All conductors shall be identified by means of labels placed on conductors in all junction boxes and at each terminal point with labels indicating source, circuit number or terminal number.
2. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.
3. Identify each control voltage conductor or cable on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

B. Conductors, in all sizes of cable, shall have continuous solid insulation color(s) from the manufacturer. Taped ends shall not be acceptable.

1. Conductors shall be color coded as follows:
   a. 120/208 Volt Conductors
      1) Phase A: Black
      2) Phase B: Red
      3) Phase C: Blue
      4) Neutral: White
      5) Ground: Green
      6) Isolated Ground: Green/Yellow
   b. 277/480 Volt Conductors
      1) Phase A: Brown
      2) Phase B: Orange
      3) Phase C: Yellow
      4) Neutral: Gray or White with Brown tracer
      5) Ground: Green
      6) Isolated Ground: Green/Yellow
   c. Isolated Power Conductors (Type XLP or XHHN-2)
      1) Phase A - Brown
      2) Phase B - Orange
      3) Phase C - Yellow
      4) Neutral - White with brown tracer stripe
      5) Note: Provide each phase with tracer color other than white, green, or gray.

d. Note: Further identify isolated power conductors with ½" wide purple tape at all terminations and junctions.

2. Control voltage wiring color coding shall be consistent throughout the project and shall match existing equipment and standards where applicable. Color coding for each system shall be unique.
3. Conductors within enclosures that may be energized when enclosure disconnect is off - yellow, or taped with 1/2" yellow tape every 6" of length, inside enclosure. Provide lamacoid plate warning sign on front of enclosure where this condition occurs.
4. DC Wiring:
   a. Positive: Light Blue
   b. Negative: Dark Blue

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Visual Inspections:

1. Compare cable data with drawings and specifications.
2. Inspect exposed sections of cable for physical damage and correct connections in accordance with drawings.
3. Inspect bolted electrical connections for high resistance. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
4. Inspect compression-applied connectors for correct cable match and indentation.
5. Inspect for correct identification and arrangements.
6. Inspect cable jacket insulation and condition.

C. Electrical Tests:

1. Perform insulation resistance testing for all electrical distribution system feeders unless notes otherwise. Testing may be witnessed by the Engineer and/or Commissioning agent. Schedule all tests with Architect with sufficient notice.
2. Insulation resistance tests shall be performed at a DC voltage of 1,000 volts for 600 volt rated equipment, and at a DC voltage of 500 volts for 120-300 volt rated equipment. Test duration shall be one minute. Minimum acceptable (temperature corrected) resistance is 25 megaohms for 120-300 volt rated equipment and 100 megaohms for 600 volt rated equipment and wiring.
3. Test instruments shall be calibrated to national standards within the last 12 months.

D. Test and Inspection Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Cables will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.

F. Submit test results to Architect and Engineer for approval

END OF SECTION

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Description: Grounding and Bonding for electrical systems covers several different but interrelated systems including Electrical System Grounding, Equipment Grounding System, Grounding Electrode System, and interfaces with telecommunications bonding infrastructure as well as lighting protection systems.

B. Section includes requirements for electrical system and equipment grounding, plus the following special applications:

1. Underground distribution grounding.
2. Grounding electrodes.
3. Ground bonding common with lightning protection system.

C. Related Requirements:
1. Refer to Section 270000 "Voice Data Systems" for requirements associated with the telecommunications bonding infrastructure.

1.3 REFERENCES

A. Abbreviations

1. MGB: Main Grounding Busbar

B. Definitions

1. Grounding: Establishing a direct or indirect connection to Earth or some conducting body that serves in place of Earth.
2. Bonding: Method by which all non-energized conductive materials are effectively interconnected to create a low impedance path.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. National Electrical Contractors Association (NECA)
   a. NECA 331 – Standard for Building and Service Entrance Grounding and Bonding

1.4 SUBMITTALS

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

B. Coordination Drawings: Plans showing dimensioned locations of grounding electrodes, test wells, and other grounding features.

C. Field quality-control reports. Provide test reports for each test specified in the field quality control section. Include copies of current equipment calibration certification.

D. Closeout Submittal:
   1. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
   2. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
      a. Instructions for periodic testing and inspection of grounding systems and features based on NETA MTS and NFPA 70B.
         1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
         2) Include recommended testing intervals.
   3. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
      a. Test wells.
      b. Grounding electrodes and connections.
      c. Grounding arrangements and connections for separately derived systems.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

B. Comply with NFPA 70 and UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:
   1. ABB Blackburn
   2. Eaton B-Line
   3. Harger
   4. Hubbell Burndy
   5. Ilsco
   6. nVent Erico
   7. Panduit
   8. VFC Lyncole

2.3 CONDUCTORS

A. Insulated Copper Conductors: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables".

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

C. Straps/Jumpers: Copper tape, braided conductors pre-terminated with copper ferrules, cross-sectional area no less than a No. 6 AWG conductor.

2.4 ELECTRICAL SYSTEM BUSBARS

A. Grounding Busbar: Predrilled rectangular bars of annealed copper, minimum 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Size busbar length to accommodate initial conductor installation plus a 50% growth factor. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 1000 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.5 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits consisting of graphite molds, copper oxide and aluminum weld metal, and electronic ignition system. Provide types recommended by kit manufacturer for materials being joined and installation conditions.

C. Irreversible Compression Connectors: Tin-plated copper, for installation using a hydraulic compression tool and die matched to connector type. Provide with die code or other visual indicator to ensure proper connector selection and uniform compression for a permanent connection.

1. Taps: C-type, H-type, or Figure 6/8 type.
2. Splices: Long Barrel straight or tee.
3. Terminals: Two-hole lug long barrel type.

D. Mechanical Connectors: Tin-plated high strength copper alloy or high strength cast bronze
1. Water Service Pipe Clamps: Heavy-Duty, two-piece saddle type with stainless steel bolts.
2. Pipe Clamps: Heavy-Duty, U-bolt type with silicon bronze hardware.
3. Lay-in Lug Connector: Heavy-Duty, open face lug with hex head set screw.

2.6 GROUNDING ELECTRODES

A. Ground Rods: 10 mil pure electrolytic copper coating with molecular bond to high strength steel core; 3/4 inch by 10 feet with chamfered end. Ensure ground rods are die-stamped near the top with the name and trademark of the manufacturer and the length in feet.

B. Enhanced Composite Backfill: Electrically conductive, environmentally-safe, maintenance free backfill material with neutral PH properties that creates a stable, non-corrosive, low resistance connection between a grounding electrode and earth. Basis of Design: Erico Ground Enhancement Material (GEM).

C. Test Well: Lightweight polymer concrete, Tier 15 rated, non-slip cover, suitable for non-deliberate incidental traffic. 12-inch by 12-inch minimum, 12-inches deep unless noted otherwise, with "GROUND" legend unless noted otherwise.

PART 3 - EXECUTION

3.1 GENERAL

A. Bond grounding bus and all non-current carrying metallic parts of raceways systems and equipment to common ground in accordance with the National Electrical Code, NECA 331, as shown on the Contract Drawings, and in accordance with the requirements of the local authority having jurisdiction.

B. The size of the grounding and bonding conductors shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings.

C. Interconnect all grounding systems in or on the structure to provide a common ground potential.

D. Bond all outlet, junction, pull boxes, and enclosures to the equipment grounding conductor with a grounding pigtail.

3.2 APPLICATIONS

A. Conductors: Install solid conductor for #10 AWG and smaller, and stranded conductors for #8 AWG and larger unless otherwise indicated.

1. Install bare conductors where not specifically identified as bare or insulated except where installed in conduit with associated phase conductors. Install insulated conductors in conduit with insulation of the same material as the associated phase conductors with which it is installed.
2. Provide insulated conductors not exceeding No. 8 AWG in size with green colored insulation. Identify conductors larger than No. 6 AWG with 4-inch green tape at each termination and at all junction and pull boxes.

B. Underground Grounding Electrode Conductors: Install bare copper conductor, sized per NEC or as indicated on drawings, whichever is larger.

1. Bury at least 24 inches below grade or below the frost line depth, whichever is greater.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Electrical System Grounding Busbar: Install in electrical rooms housing service equipment, and elsewhere as indicated to provide a common connection point for individual grounding electrode conductors and bonding jumpers.

1. Install bus horizontally, on insulated spacers 4 inches minimum from wall, 18 inches above finished floor unless otherwise indicated.

2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
3. Provide green laminated plastic nameplate with 1/2" high white letters indicating function of ground bus (i.e. "Service Main Ground Busbar").

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Connections: Mechanical connectors.
2. Underground and Exposed Exterior Connections: Exothermic welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Mechanical connectors.
4. Connections to Structural Steel: Exothermic welded connectors.
5. Connections to Busbars: Irreversible compression connectors.

3.3 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the neutral bus except where service equipment neutral and ground bussing complies with exceptions listed in the NEC. Install a main bonding jumper between the neutral bus and ground bus. Provide external grounding busbar and install grounding electrode conductor to interconnect main grounding busbar and neutral bus.

B. Where ground fault protection is installed, ensure interconnection of neutral bus and ground bus does not interfere with correct operation of fault protection.

3.4 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Transformers: Provide grounding in accordance with the NEC and the following:

1. System Bonding Jumper (SBJ): Install at the source enclosure between the grounded terminal (neutral) and the equipment grounding terminal.
2. Supply Side Bonding Jumper (SSBJ): Install wire type SSBJ to bond the source enclosure to the enclosure at the first disconnect or overcurrent protective device.
3. Grounding Electrode Conductor (GEC): Install at the source enclosure from the SBJ connection point to the building grounding electrode system.
4. Bonding Jumpers: Where the metal water piping and/or the metal structural steel building frame in the area served by the separately derived system are not used as a grounding electrode, provide bonding jumper to the GEC connection point at the source enclosure.
5. Equipment Grounding Conductor (EGC): Bond the EGC of the primary feeder to the equipment grounding terminal.

3.5 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements for utility equipment.

B. Exterior Pad-Mounted Equipment: Install a minimum of two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with equipment by connecting them to underground grounding conductors and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.6 EQUIPMENT GROUNDING AND BONDING

A. Equipment Grounding Conductors: Install insulated equipment grounding conductors with all feeders and branch circuits. Provide conductors of the same wire/cable type as the ungrounded current carrying conductors.

B. Increase equipment grounding conductor sizes in accordance with NEC article 250 where ungrounded current carrying conductor sizes are increased to minimize voltage drop.

C. Provide all circuits with a dedicated equipment grounding conductor unless noted otherwise.

D. Provide an equipment grounding conductor to each outlet on circuits protected by a GFCI circuit breaker.

E. At all metallic outlet, junction and pull boxes, bond the equipment grounding conductor to the enclosure.

F. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

G. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

H. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

I. Metal Poles Supporting Outdoor Lighting Fixtures: Install a ground rod and a separate insulated equipment grounding conductor at each pole in addition to grounding conductor installed with branch-circuit conductors.

3.7 INSTALLATION

A. Grounding Electrode Conductors and Bonding Jumpers: Securely fasten and route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

1. Route conductors to maintain a downward or horizontal direction to ground with a minimum bend radius of 8-inches.
2. Protection: Install above grade conductors No 6 AWG or larger exposed to physical damage and all conductors smaller than No. 6 AWG in schedule 80 PVC conduit. Where metallic conduit is required, bond each conduit end to the electrode or ground conductor as close to the openings as possible with a full-size conductor and bonding bushing to create an electrically parallel path.

3. Clearance: Maintain a minimum separation of 12-inches from open telecommunications cable groups.

B. Ground Rods: Auger 6 inch diameter hole to depth 6 inches shorter than the ground rod length. Drive rods a minimum of 12 inches into the bottom of the hole until tops are 12 inches below final grade. After installing connections, backfill around ground rod with enhanced composite backfill.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Except at test wells, use exothermic welds for all below-grade connections to ground rods.
3. For grounding electrode system at the service, install at least three rods spaced at least two-rod lengths from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole.

1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts. Install straps and jumpers such that it does not restrict movement of the structure to which it is connected.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes using a mechanical connector. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Other Metal Piping: Bond each aboveground portion of metal piping systems, including gas piping, downstream from its equipment shutoff valve in an accessible location.
4. Except for water piping, do not utilize piping systems as a ground path where dielectric fittings are utilized. Do not use bonding jumpers to bridge over such fittings.
5. Do not use underground portions of natural gas, flammable gas, or liquid fuel piping as grounding electrodes.

F. Grounding for Steel Building Structure:

1. Where the building's steel frame is made discontinuous by masonry breaks or expansion joints, provide an accessible No. 500 kcmil bare copper jumper with exothermic weld connections to bond steel sections together, making the steel frame electrically

continuous. The installation of the bonding jumpers shall be reviewed by the Engineer before covering.

G. Concrete-Encased Grounding Electrode (Ufer Ground): Provide and fabricate in accordance with NFPA 70; use a minimum of 20 feet bare copper conductor no smaller than #4 AWG located in building footing that has direct contact with earth.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts using exothermic weld connections. Extend grounding conductor below grade and connect to building's ground ring or to grounding electrode external to concrete.

H. Exothermic Welded Connections: Provide in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

1. An electronic ignition system shall be used and weld metal shall be a self-contained, sealed system with a bi-metallic fuse to start the reaction.
2. Comply with AWS Standards and manufacturer's instructions for procedures, appearance, and quality of welds; and methods used in correcting welding work.
3. Ensure process joins all strands and does not cause the parts to be damaged or weakened.
4. Completed connection or joint must be equal or larger in size than the conductors joined and have the same current-carrying capacity as the largest conductor.

I. Mechanical Connections: Install mechanical connections in accessible locations.

1. Tighten connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values.
2. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

J. Connections between Dissimilar Metals: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Clean surfaces and apply anti-oxidant compound prior to installation of connections.
2. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
3. Make connections with clean, bare metal at points of contact.
4. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
5. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.8 FIELD QUALITY CONTROL

A. Buried or concealed grounding electrode systems shall be accepted by Engineer and Owner Representative before backfilling or covering.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Bond Resistance Test: Test the bonding connections of the system using a certified micro-ohmmeter, taking two-point resistance measurements across each bond in the grounding electrode system. The maximum acceptable value of each bond is 0.5 milliohms.
3. After completing installation of the grounding electrode system and finished grade, but before permanent electrical circuits have been energized, test for compliance with requirements.
4. Grounding Electrode Resistance Test: Test completed grounding electrode system at service disconnect enclosure grounding terminal and at ground test wells using a manufacturer calibrated and certified 3-point ground resistance tester.
    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by three-point fall-of-potential method according to IEEE 81.
    c. Disconnect and isolate the grounding electrode conductor from the electrical system at the main ground bus before testing.
    d. Install outer test probe outside the sphere of influence of the grounding electrode system. This value is typically 10 times the size of the grounding electrode system, between 300 and 500 feet from the main ground bus.
    e. Install inner test probe at 10 equally spaced intervals, in a straight line between the grounding electrode system connection and the outer test probe and note the resistance reading at each location.
    f. The resistance measurements taken from the flat part of the curve shall be averaged to determine the grounding electrode system resistance to earth.
    g. If large variations are noted in the resistance measurements, the outer test probe should be relocated further from grounding electrode system (outside its sphere of influence) to achieve some degree of flatness on the resistance curve.
    h. Excessive Ground Resistance: If resistance to ground exceeds 5-ohms, notify Engineer promptly and include recommendations to reduce ground resistance. If deemed necessary by the Engineer, additional electrodes shall be placed and the measurement process repeated until the desired ground potential achieved.
5. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include test probe locations, observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare detailed test and inspection reports and submit to Engineer for review.

END OF SECTION

SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 – General Requirements for Electrical Systems apply to this Section.

1.2 SUMMARY

A. This section is intended to specify the raceways, fittings, boxes, cabinets, specialties and related items necessary to complete the work as shown on the drawings and specified herein.

B. Section Includes:

1. Metal conduits and fittings
2. Nonmetallic conduits and fittings
3. Surface metal raceway
4. Metal wireways and auxiliary gutters.
5. Boxes, enclosures, and cabinets
6. Wall ducts and trench ducts.

C. Related Requirements:

1. Refer to Division 07 firestopping section and Section 260010 "General Requirements for Electrical Systems" for penetration firestopping requirements related to electrical pathways and boxes.

1.3 REFERENCES

A. Abbreviations

1. EMT: Electrical Metallic Tubing
2. FMC: Flexible Metal Conduit
3. GRC: Galvanized Rigid Steel Conduit
4. IMC: Intermediate Metal Conduit
5. LFMC: Liquid-tight Flexible Metal Conduit.
6. RAC: Rigid Aluminum Conduit
7. RMC: Rigid Metal Conduit

B. Definitions

1. Outlet: A point on the wiring system at which current is taken to supply utilization equipment.
2. Raceway: an enclosed channel designed for enclosing and protecting electrical, communications, and signaling wires and cables.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. National Electrical Contractors Association (NECA)
   a. NECA 101 - Standard for Installing Steel Conduits (RMC, IMC, EMT)
   b. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)
2. National Electrical Manufacturers Association (NEMA)
   a. NEMA FB 2.10 - Selection and Installation Guidelines for Fittings for Use with Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing)
   b. NEMA FB 2.20 - Selection and Installation Guidelines for Fittings for Use with Flexible Electrical Conduit and Cable
   c. NEMA RV 3 - Application and Installation Guidelines for Flexible and Liquid-tight Flexible Metal Conduits

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Shop drawings: For custom enclosures, cabinets, or boxes.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

2.2 METAL CONDUIT AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Anamet Electrical, Inc.
4. Calconduit
5. Electri-Flex Company.
6. Nucor Tubular Products.
7. O-Z/Gedney.
8. Picoma Industries.
9. Robroy Industries.
10. Southwire Company.
11. Thomas & Betts Corporation.
12. Western Tube and Conduit Corporation.

13. Wheatland Tube Company.

B. Electrical Metallic Tubing (EMT) and Elbows:

1. Comply with ANSI C80.3 and UL 797.

C. Galvanized Rigid Steel Conduit (GRC, RMC) and Elbows:

1. Comply with ANSI C80.1 and UL 6.
2. Zinc coating both inside and outside by means of hot-dip galvanizing.
3. Use only threaded fittings for GRC.

D. Intermediate Metal Conduit (IMC) and Elbows:
1. Comply with ANSI C80.6 and UL 1242

E. Flexible Metal Conduit (FMC):

1. Comply with UL 1.
2. Continuous interlocked hot-dip zinc galvanized steel with smooth interior and exterior.
3. Suitable for dry locations.

F. Liquid-tight Flexible Metal Conduit (LFMC):

1. Comply with UL 360.
2. Continuous interlocked hot-dip zinc galvanized steel core with smooth interior and exterior.
3. Suitable for wet and dry locations, direct burial applications, and concrete encasement.
4. Sunlight resistant, flame retardant thermoplastic PVC jacket resistant to heat, oil, and chemical breakdown.

G. Metal Fittings

1. Comply with NEMA FB1 and UL 514B.
2. Listed and labelled for type of conduit, location, and use.
3. Fittings for EMT:
   a. Compression type, zinc-plated galvanized steel.
   b. Concrete-tight- or rain-tight, hardened steel locknuts, and nylon insulating throats.
4. Fittings for GRC and IMC:
   a. Threaded zinc plated steel.
   b. Concrete-tight- or rain-tight, nylon insulating throats.
5. Conduit Bodies:
   a. Material: gray iron or heavy copper-free cast aluminum
   b. Available in varying configurations with integral bushing and gasketed coverplate.
6. Expansion/Deflection Fittings: UL 651 listed, manufactured coupling accommodating 3/4-inch linear movement from normal and 30-degree angular movement in all directions
   a. Basis of Design: OZ/Gedney DX
   b. PVC or steel sleeve to match conduit type with neoprene jacket, rated for environmental conditions where installed.
   c. Integral braided copper bonding jumper.
7. Fittings for FMC and LFMC:
   a. LFMC: Tubular Steel, zinc-plated with gland nut, sealing ring, high tensile grounding ferrule, insulated throat, and body for liquid tight connection.
8. Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
9. "Kwik-Couple" type fittings are not permitted.
10. Indentation, set-screw, or die-cast fittings are not permitted.

H. Joint Compound for threaded conduit: UL 2419 listed for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.3 NON-METALLIC CONDUITS AND FITTINGS

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

1. Allied Tube & Conduit
2. Cantex
3. Carlon
4. Heritage Plastics
5. National Pipe & Plastics
6. Prime Conduit

B. Rigid Polyvinylchloride (PVC) Conduit:

1. Comply with NEMA TC-2 and UL 651.
2. Sunlight resistant and suitable for use with 90 degree C conductors.
3. Type EPC-40 suitable for normal duty applications.
4. Type EPC-80 suitable for heavy duty applications.

C. Non-Metallic Fittings

1. Comply with NEMA TC 3 and UL514B.
2. Listed and labelled for type of conduit, location, and use.
3. Compatible with conduit type and material.
4. Solvents and Adhesives: as recommended by conduit manufacturer.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. Eaton B-Line
2. Hubbell Wiegmann.
3. nVent Hoffman.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise required by environmental application, and sized according to NFPA 70. Minimum of 14-gauge steel before finishes are applied.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

1. Provide knockouts on all runs, unless otherwise indicated or prohibited by codes.
2. Provide dividers to separate conductors of different insulation levels or where required by equipment vendor installation instructions.

D. Wireway Covers: Furnish with continuous hinged covers on all runs and removable covers on all fittings unless otherwise noted, to allow a continuous unobstructed path for conductor installation.

E. Finish: Manufacturer's standard enamel finish resistant to corrosion, moisture, and oil.

F. Size: available in nominal sizes 2-1/2-inch by 2-1/2-inch, 4-inch by 4-inch, 6-inch by 6-inch or 12-inch by 12-inch.

G. Install supports to allow unobstructed access to wireway interior. Use minimum 1/4-inch rod hangers for up to 4-inch by 4-inch wireway, 3/8-inch rod up to 8-inch by 8-inch wireway, and 1/2-inch rod for 12-inch by 12-inch wireway.

2.5 BOXES, ENCLOSURES, AND CABINETS

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

1. Eaton Crouse-Hinds.
2. Emerson/Appleton Electric.
3. FSR Inc.
4. Garvin Industries
5. Hoffman.
6. Hubbell Killark.
7. Milbank Manufacturing Co.
8. Mono-Systems, Inc.
9. O-Z/Gedney.
10. RACO / Hubbell.
11. Stahlin Non-Metallic Enclosures.
12. Thomas & Betts.
13. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed for intended use.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

E. Luminaire Outlet Boxes: Non-adjustable, designed for attachment of luminaires, listed and marked for the maximum allowable weight with at least a 2.0 safety factor for the anticipated fixture weight.

F. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, constructed of code gauge, galvanized steel with sides formed and corner seams riveted or welded before galvanizing

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. For box extensions and mud rings used to accommodate building finishes, provide with same material as recessed box.

J. Minimum Device Box Dimensions unless noted otherwise:

1. Single gang: 4-inches square by 2-1/8-inches deep with single gang extension ring.
2. Two gang: 4-inches square by 2-1/8-inches deep with two-gang extension ring.
3. Three gang: 8-5/8-inches by 4-1/2-inches by 2-1/2-inches deep with three gang extension ring.
4. Four gang: 10-7/16-inches by 4-1/2-inches by 2-1/2-inches deep with four gang extension ring.

K. Gangable boxes are prohibited.

L. Boxes assembled with sheet metal screws are prohibited.

M. Hinged Cover Enclosures: Comply with UL 50 and NEMA 250, suitable for installed environment with continuous-hinge cover and flush latch unless noted otherwise.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Fiberglass
3. Interior Panels: Steel, all sides finished with manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.

B. Apply raceway products as specified below unless otherwise indicated:

1. Refer to Section 260543, "Underground Ducts and Raceways for Electrical Systems" for additional requirements related to raceways installed underground outside of the building footprint.
2. Exterior and Exposed: GRC
3. Concealed Underslab: GRC or PVC Type EPC-40 where approved.
4. Interior, Concealed in Ceilings, Walls, and Partitions: EMT, IMC, or GRC
5. Interior, Concealed in Concrete or Grouted Masonry Walls and Partitions: IMC or GRC
6. Interior, Damp or Wet Locations: GRC
7. Interior, Where exposed and Not Subject to Physical Damage: EMT, GRC, or IMC. Raceway locations include the following:
   a. Electrical Rooms
8. Interior, Where Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
   a. Mechanical rooms (below 8'-0").
9. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
10. Connection to ceiling mounted recessed and semi-recessed luminaires and electrical devices: FMC.
11. Boxes and Enclosures: NEMA 250, Type 1 except as follows:
    a. Damp or Wet locations: NEMA 250, Type 3R

12. Exposed Boxes subject to physical damage: Die cast metal boxes with threaded hubs.
13. EMT is not permitted underslab, embedded in concrete slabs, or where exposed to physical damage.
14. Non-metallic conduit is not permitted for the following applications unless approved by the Engineer:
    a. Interior Locations including environmental air plenums.
    b. Applications where a redundant ground fault path is required by code.
15. Flexible non-metallic conduit is not permitted.

16. Unless otherwise indicated on the drawings, intermediate metal conduit (IMC) may be used in any location in place of rigid galvanized steel conduit (GRC), where permitted by codes, and where approved by the Engineer.

C. Minimum Raceway Size: 3/4-inch trade size unless noted otherwise on the drawings.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only steel fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth or where prolonged contact with construction materials will degrade the aluminum.

F. Install raceways and fittings in a manner to avoid use of dissimilar metals that would result in galvanic action corrosion.

G. Install surface conduits or raceways only where indicated on Drawings.

H. Do not install surface conduits or raceways on exterior facades unless approved by Engineer.

I. Do not install nonmetallic conduit where ambient temperature or operating temperature of the conductors exceeds the rating of the raceway.

J. Conduit installed embedded in concrete slabs is not permitted.

3.2 RACEWAY INSTALLATION

A. Comply with requirements in Section 260500 "Common Work Results for Electrical Systems" for hangers and supports.

B. Comply with NECA 1, NECA 101, NECA 111 and manufacturer's written instruction for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Complete raceway installation before starting conductor installation.

D. Comply with utility company requirements for raceways and boxes containing utility company conductors.

E. Size raceways to conform with Annex C, of the National Electrical Code, unless otherwise shown on the Contract Drawings.

F. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure wherever possible, to maximize available space and not restrict other trades.

G. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated.

H. Install conduits with runs parallel or perpendicular to building lines, walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends unless otherwise shown. Randomly routed conduits are not acceptable.

I. Make bends in raceway using large-radius preformed elbows. Provide concentric bends for parallel runs of conduit. Conform with NFPA 70 minimum radii requirements for field bending. Use only equipment specifically designed for material and size involved.

J. Install no more than the equivalent of three 90-degree bends in any conduit run. Support within 12-inches of changes in direction.

K. Provide junction boxes or pull boxes so that conduit runs do not exceed 100 feet, or as shown on the Contract Drawings. Size junction boxes per NEC, Article 370.

L. Provide conduit supports spaced not more than 8-feet apart.

M. Support conduit within 12-inches of enclosures to which attached.

N. Do not drill into bar joists to support raceways or cables.

O. Install conduits at least 12-inches away from flues, steam or hot water pipes.

P. Conduit installed under concrete slabs is permitted for feeders and for branch circuits serving floor outlets. Underslab conduit is prohibited for other locations unless noted on the drawings or with permission of the engineer. Where approved, comply with the following:

1. Locate raceway a minimum of 12-inches below the bottom of slab.
2. Provide minimum 2-inch spacing between conduits to ensure proper compaction of structural fill.
3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
4. Transition underslab RNC to GRC for all bends larger than 20-degrees and for all stub-ups through a slab on grade. Arrange stub-ups so curved portions of bends are not visible above finished slab. Extend GRC stub-ups a minimum of 6" above the concrete slab. Schedule 80 PVC stub-ups are allowed where approved by engineer.
5. Seal around conduits when penetrating vapor barriers.
6. Where installed in corrosive soils, coat all underslab rigid steel conduit with two coats of bitumastic paint such as "Asphaltum".

Q. Where raceways are subject to environmental changes, locate seals immediately at the boundary so no fittings or boxes are between the seal and the change of environments that would allow migration of condensation within the raceway system. Seal the interior of all raceways at the following points:

1. Where conduits pass from cold to warm locations, such as boundaries of refrigerated spaces and at building wall and roof penetrations.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

R. Install conduits in a manner so as to ensure against collection of trapped condensation. Arrange all runs of conduit so as to be devoid of traps. Provide trapped conduit runs with explosion proof drains at low points.

S. At hazardous locations, install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed non-shrink sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

T. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

U. Complete installation of electrical raceways before starting installation of cables or wires within raceways.

V. Take precautions to prevent the lodgment of dirt, plaster, or trash in all conduit or tubing, fittings and boxes during construction. Use mandrel to clean all conduit for floor boxes or conduit below grade and ensure its swabbed free of debris or moisture before wiring is installed.

W. Unless using GRC, do not locate conduits, cables, raceways, and enclosures within 2 inches of bottom of metal-corrugated sheet roof decking, measured from the lowest surface of the roof decking to the top of the conduit, cable, raceway, or box.

X. Conduits, cables, raceways, and enclosures are not permitted in concealed locations of metal-corrugated sheet decking type roofing.

Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72-inches of flexible conduit for ceiling mounted recessed and semi-recessed luminaires, and 36-inches for all other equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Install as a single piece with clamp-on insulated throat connectors designed for the purpose.
2. Provide strain relief fittings where subject to vibration.
3. Provide an equipment grounding conductor and bonding jumper at all locations.
4. For LFMC, provide a minimum of 18-inches and loop to avoid restraining vibrating equipment.

Z. Stub-ups to Accessible Ceilings:

1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or into an enclosure.
2. Where conduits terminate at a cable tray pathway, provide listed fitting to secure conduit to cable tray.

AA. Mechanically fasten conduit terminations at a wireway, provide metal insulated bushings, and bond to the wireway with bonding jumper.

BB. Furnish conduit bodies in proper configurations, avoiding excessive openings. Any openings that are left shall be properly plugged. Wiring splices within conduit bodies are not permitted.

CC. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

DD. Provide a completely separate raceway system, including junction boxes and pull-boxes, for each emergency power, optional stand-by, and normal power system for complete separation in accordance with NEC.

EE. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of secured slack at each end of pull wire. Secure pull string at each end and cap raceways.

FF. Coordinate with vendors and provide extra pull-strings as required to ensure sufficient number of pull strings.

GG. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.

HH. Raceway Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines

1. Install raceways square to enclosures and terminate with appropriate fitting:
2. For enclosures without hubs, terminate with appropriate fitting, insulated throat liner, and case-hardened locknuts on both sides of enclosure wall.
3. Terminate rigid conduits with threaded hubs or with locknuts on inside and outside of enclosure and insulated throat metal bushing.
4. Install locknuts hand tight, plus one-quarter turn more.
5. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
6. All threaded fittings shall engage a minimum of seven full threads. Fasteners shall be properly torqued to manufacturer's recommendations.
7. Split sleeve insulators are not permitted.

II. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

JJ. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

KK. Where raceways penetrate rooms or walls with acoustical requirements, seal raceway openings on both sides of penetration with acoustically rated putty or sealant.

LL. Do not install raceways or electrical items on "explosion-relief" walls.

3.3 BOX AND ENCLOSURE INSTALLATION

A. Provide electrical outlets and enclosures as required for splices, taps, wire pulling, and equipment connections.

B. Provide pull boxes as required to maintain conduit run and bend limitations specified herein.

C. Size all outlets, pull boxes, junction boxes, cabinets, etc., per adopted edition of the National Electrical Code.

D. Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

E. Install interior and exterior outlet boxes recessed in building construction with face or cover flush with finished surfaces unless noted otherwise. Where outlet boxes are installed in walls of glazed tile, brick, concrete block, or in walls covered by wood wainscot or paneling, provide deep box to ensure the outlet boxes are installed straight and secure in walls.

F. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements and architectural elevations. Install boxes with height measured to center of box unless otherwise indicated.

G. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box. Do not split the mortar joint

H. Provided 3/4-inch rigid conduit pendants where lighting fixtures, appliances, or wiring devices are to be suspended from ceiling outlet boxes. Outlet boxes shall be malleable iron, provided with self-aligning covers with swivel ball joint and #14 gauge steel locking ring. Provide safety chain between building structure and housing for all fixtures, appliances or devices greater than 10 lbs weight. Install fixtures plumb and level. Cover pendants shall be finished to match fixtures.

I. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

J. Locate boxes so that cover or plate does not span different building finishes.

K. Provide spanner bars to support all boxes from more than one side by spanning two framing members.

L. Fasten boxes up to 4-11/16 square size to their mounting surface or support with two fasteners of proper size. Fasten larger sizes with four fasteners, minimum.

M. Support boxes recessed in ceilings independent of ceiling tiles and ceiling grid.

N. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits or ceiling support wires.

O. Provide all cabinets and boxes for NEMA 1 applications with knockouts, as necessary, or field cut with approved cutting tools which will provide a clean, symmetrically cut opening to maintain UL listing of enclosure.

P. Replace any unused knockouts or openings with a listed knockout closure.

Q. Coordinate with equipment vendors to provide special sized outlet boxes to support installed equipment.

R. Where boxes and enclosures are located in areas or on walls with acoustical requirements, seal openings and knockouts in back and sides of boxes with acoustically rated putty or sealant and provide gasket for wall plates and covers.

3.4 GROUNDING AND BONDING

A. Bond all metal boxes, junction boxes and pull boxes with pigtails to the equipment grounding conductor.

B. Provide insulated throat grounding bushings with appropriately sized bonding jumpers for the following locations to maintain electrical continuity between the raceway and enclosure:

1. Metal raceways and enclosures that contain service conductors.
2. Metal raceways and enclosures that contain grounding electrode conductors.
3. Where metal raceways containing circuits over 250V terminate in a concentric or eccentric knockout at cabinets, enclosures, or sheet metal pull boxes listed in accordance with UL 50.
4. Where the integrity of a concentric or eccentric knockout has been compromised.
5. Metal raceways and enclosures that contain feeders.

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

B. Protect threads on conduits and fittings with plastic protectors or other means to prevent damage prior to installation.

C. Provide protection for all conduit stubbed through floor during construction with plastic caps approved for this purpose.

3.6 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify all junction, outlet and pull boxes in data/mechanical/electrical rooms and above ceilings with panel and circuit designation on outside of covers. Identify all exposed junction, outlet and pull boxes in finished areas with panel and circuit designation on inside of covers.

C. Coordinate finish on exposed conduit with architect and GC.

3.7 PAINTING

A. Raceways installed in exterior locations shall receive one coat of primer, two coats finish paint after preparation of galvanizing, color selected by Architect.

B. Exposed raceways in painted interior areas shall be painted to match adjacent finishes.

END OF SECTION

SECTION 260543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Direct-buried and concrete-encased conduits, ducts, and duct accessories.
2. Handholes and boxes.
3. Utility Structure accessories.

B. Related Requirements:

1. Refer to Section 260533 "Raceways and Boxes for Electrical Systems" for pathway requirements installed under building slabs.

1.3 REFERENCES

A. Abbreviations

1. GRC: Galvanized rigid conduit.
2. IMC: Intermediate metal conduit.
3. RNC: Rigid nonmetallic conduit.

B. Definitions

1. Backfill: Earth or other controlled material placed in trenches for filling and grading back to a finished state.
   a. Initial Backfill (encasement): Backfill placed beside and over conduit arrangements in a trench, including haunches to support sides of conduits.
   b. Final Backfill: Backfill placed over initial backfill to fill a trench.
2. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying conduit.
3. Duct: A single or multiple underground conduits encased in concrete or direct buried.
4. Duct Bank: An arrangement of two or more ducts installed together.
5. Encasement: Material placed around a duct or duct bank to provide additional protection.
6. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. National Electrical Manufacturers Association (NEMA):
   a. NEMA TCB-2 “Guidelines for the Selection and Installation of Underground Nonmetallic Raceways”.

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Field quality-control reports including digital photographs of all concealed work.

C. Closeout Submittals
   1. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", ensure all utilities, structures, and underground conduits are surveyed and recorded on as-built drawings.

1.5 FIELD CONDITIONS

A. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C2 and NFPA 70.

2.2 CONDUITS AND FITTINGS

A. Comply with 260533 “Raceways and Boxes for Electrical Systems”.

2.3 DUCT ACCESSORIES

A. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during encasement or backfilling.

B. Fabric Innerduct: Continuous, nylon resin polyester, multi -pocket fabric innerduct, with internal pull tape. Maxcell or equal.

C. Pull Line: Flat, woven, polyester or polyaramid tape, low stretch, pre-lubricated for reduced friction. Strength suitable for required pulling tensions with a minimum of 200-lb. Muletape or equal.

D. Underground Detectable Warning Tape: Flexible tape constructed with solid aluminum foil backing and clear film laminate, 6-inches wide, 5-mil overall thickness.

1. Suitable for the method of installation and locating underground utility lines.
2. Chemically inert tape material and ink, resistant to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
3. Comply with APWA Uniform Color Code.
4. Inscriptions for Red-Colored Tapes: "CAUTION BURIED ELECTRIC LINE BELOW".
5. Inscriptions for Orange-Colored Tapes: "CAUTION BURIED COMMUNICATIONS LINE BELOW".

E. Duct Sealants: Re-enterable, two-part, closed-cell urethane foam capable of sealing conduits with multiple cable configurations.

1. Capable of withstanding temperatures from -40 deg F to 200 deg F and holding 22 feet waterhead pressure continuous.
2. Chemically resistant to gasoline, oils, dilute acids and bases.
3. Compatible with cable jacket and shall not affect the physical or electrical properties of wire and cable.
4. Workable at temperatures as low as 35 deg F.
5. UL94 Class HBF fire retardant rating.

2.4 POLYMER CONCRETE HANDHOLES AND BOXES

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

1. Armorcast
2. NewBasis
3. Oldcastle
4. Hubbell Quazite

C. General Requirements:

1. Comply with SCTE 77. Minimum Tier 15.
2. Color: Gray.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, as indicated for each service.

2.5 PRECAST CONCRETE MANHOLES AND HANDHOLES

A. Description: Factory fabricated, one-piece units and units with interlocking mating sections, complete with accessories, hardware, and features. Frame and cover shall have load rating consistent with that of structure.

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

1. Christy Concrete Products

2. Oldcastle
3. Utility Concrete Products
4. Utility Vault Co

C. Comply with ASTM C 858.

D. Precast reinforced-concrete, H-20 structural load rating according to AASHTO HB 17.

E. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

1. Locate windows no less than 6 inches from interior surfaces of walls, floors, or roofs of structure, but close enough to corners to facilitate racking of cables on walls.
2. Provide window opening with cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
3. Provide window opening frame with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
4. Provide windows 1-1/2 to 2 inches thick.

F. Duct Entrances in Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct or conduit to be terminated.
2. Fittings shall align with elevations of approaching ducts and be located near interior corners of structures to facilitate racking of cable.

G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

H. Provide ventilation openings where indicated on drawings.

I. Frames, Covers, and Chimney Components: Comply with structural design loading specified for structure.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 35 cast iron with milled cover-to-frame bearing surfaces; diameter, 32 inches.
   a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
2. Cover Legend: Cast in. Selected to suit system.
   a. All covers shall be provided with 2 inch lettering and with the structure number, assigned by Owner, welded onto the cover if not provided by the manufacturer.
   b. All covers shall be provided with stainless steel drop handles.
3. Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
   a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
   b. Seal joints watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.

J. Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

K. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch diameter eye, and 1-by-4 inch bolt.
   1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

L. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
   1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

M. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

N. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

O. Ground Rod Sleeve: 3-inch, PVC conduit sleeve in floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.

P. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

Q. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
   1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
   2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
   3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

R. Fixed Ladders & Extension: Arranged for attachment to wall of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there are obstructions or conflicts between areas of excavation and existing structures or archaeological features to remain.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

C. All necessary precautions shall be taken by the contractor during construction to prevent the lodging of dirt, plaster or trash in all conduit, tubing, fittings and boxes.

3.2 UNDERGROUND DUCT APPLICATION

A. Apply underground duct products as specified unless noted otherwise:

1. Refer to Section 260533, "Raceways and Boxes for Electrical Systems" for additional requirements related to underground conduit below building slabs.
2. Ducts for Utility Company primary conductors: comply with utility company standards unless noted otherwise.
3. Ducts for Electrical Service Secondary Conductors: RNC, Type EPC-40 PVC, in concrete-encased duct bank unless otherwise indicated.
4. Ducts for Electrical Feeders 600 V and Less: RNC, Type EPC-40 PVC, in concrete-encased duct bank unless otherwise indicated.
5. Ducts for Electrical Branch Circuits: RNC, Type EPC-40 PVC, in direct buried duct bank unless otherwise indicated.
6. Ducts for Communications Cables: RNC, Type EPC-40 PVC, in direct buried duct bank unless otherwise indicated.
7. Underground Ducts 600V and less Crossing Driveways and Roadways: RNC, Type EPC-40-PVC, encased in reinforced concrete. Extend reinforcement a minimum of 5-feet beyond the edge of paved surfaces.

B. Minimum Cover Requirements: Provide reinforced concrete encasement where minimum depths are not achievable.
1. Electrical Secondary Service and Feeders: 36-inches
2. Electrical Branch Circuits: 24-inches
3. Communications: 30-inches

C. Transition RNC to GRC for all stub-ups and building enclosure penetrations. Use fittings manufactured for RNC-to-GRC transition.

1. Arrange stub-ups so curved portions of bends are not visible above grade. Increase burial depth where required to maintain cover for curves and bends.
2. Do not use steel raceways for equipment stub-ups where prohibited by utility company standards.

D. Minimum Underground Raceway Size: 1-inch trade size unless noted otherwise on the drawings.

3.3 EARTHWORK

A. Contractor shall accept the site as they find it and remove all trash, rubbish, and material from the site prior to starting excavation work.

B. Subsurface Data

1. Subsurface investigations have been performed and the results provided with the contract documents. The information was obtained primarily for use in preparing foundation design. Each contractor may draw their own conclusions therefrom. No responsibility is assumed by the Owner for subsoil quality or conditions other than at the locations and at the time the investigations were made.
2. Materials to be excavated shall be unclassified, and shall include eart, rock, or any other material encountered in the excavation to the depth and extent indicated on the drawings and specified herein. No adjustment in the contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in excavating.

C. Benchmarks and Monuments

1. Carefully maintain all benchmarks, monuments, and other reference points. If disturbed or destroyed, replace as directed.

D. Excavation:

1. Remove rock by using hand or power tools only. Blasting is not permitted unless authorized in writing by the Architect.
2. Any damage to existing structures, exterior services, or rock intended for bearing shall be corrected by the Contractor at their own expense.
3. Take necessary precautions to control runoff of eroded earth onto the property of others or against the structures. All such damage or any other damage incurred in the course of excavation, shall be corrected by the Contractor at their own expense.

E. Trenching:

1. Cut trenches neatly and uniformly. Work with extreme care near existing ducts, conduits, and other utilities to avoid damaging them.
2. Width: Excavate trench a minimum of 3 inches wider than duct bank on each side with a minimum trench width of 12-inches.
3. Depth: Excavate to a minimum depth that equals ductbank height plus minimum cover requirements.
4. Hand excavate trench bottom to provide uniform bearing and support of conduits on an undisturbed subgrade matching slope requirement. Remove all debris, stones, and other projections.
   a. For rock or other unyielding soils, excavate trenches 6-inches deeper than required elevation and provide level 6-inch compacted sand bedding course.
   b. For unstable soils or where bedding course is subject to washout, provide concrete trench bottom.
5. Coordinate protection of roots in tree and plant protection zones with Division 31 requirements.
6. Keep trenches free from water while construction is in progress. Installation of conduit or cable in trenches with water is not permitted. Contractor is responsible for all costs associated with dewatering of trenches.

F. Final Backfill: Comply with Division 31 and as indicated below:

1. Use satisfactory soil to backfill trenches to final subgrade elevation unless required otherwise by Civil or Structural subgrade requirements.
2. Install final backfill in 6-inch layers.
3. Compact all backfill to 95% standard proctor density.
4. Mechanical means for compaction can be used once conduits have been covered with at least 12-inches of hand tamped backfill. Do not use heavy-duty, hydraulic-operated, compaction equipment.

G. Restoration:

1. Replace area immediately after backfilling is completed or after construction in immediate area is complete.
2. Restore all surface features at areas disturbed by excavation, storing of dirt, cable laying, and other work, and re-establish original grades unless otherwise indicated.
3. Restore vegetation and include 6-inches of clean topsoil, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32.

H. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" requirements in Division 01 and Section 260010, “General Requirements for Electrical”.

3.4 DUCT INSTALLATION

A. Install ducts, spacers, and accessories into ductbank configurations to accommodate duct quantities and sizes indicated on drawings.

B. Install ducts according to NEMA TCB 2.

C. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions. Install ducts in such manner to avoid traps and insure against collection of moisture.

D. Curves and Bends:

1. Use 5-degree angle couplings for small changes in direction.
2. Use manufactured long sweep bends with a minimum radius of 36 inches vertically and 60-inches horizontally, unless otherwise indicated.
3. Field manufactured bends are acceptable for a bend radius greater than 35-feet. Install field bends in accordance with NEMA TCB 2.
4. Electrical duct and duct banks: Install no more than the equivalent of three 90-degree bends in any conduit run.
5. Communications duct and duct banks: Install no more than the equivalent of two 90-degree bends in any conduit run and a maximum of 600 feet between pull points.

E. Joints: Use solvent-cemented joints in non-metallic ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same horizontal or vertical plane to ensure encasement or backfill fully surrounds each raceway.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct banks are installed parallel to underground steam lines, provide minimum 6-foot separation or perform calculations showing the duct bank will not be subject to environmental temperatures above 40 deg C. Where

environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. Installation Adjacent to Other Utilities:

1. Provide minimum 12-inches of earth or 3-inches of concrete between power and communications ducts.
2. Provide minimum 24-inches of earth between power or communications ducts and other parallel utilities. At utility crossings, provide minimum 6-inches of separation except provide 12-inches separation where crossing utility is gas or other line that transports flammable material.
3. Do not locate power and communications ducts below water and sewer lines.

H. Duct Entrances to Manholes and Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch (19 mm).
3. Grout end bells into structure walls from both sides to provide watertight entrances.

I. Building Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Provide sleeves at building penetration and make water-tight with sleeve seal.

J. Duct Support

1. For concrete encased applications, support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Separator Installation: Space separators at a maximum of 5-feet to prevent sagging and deforming of ducts. Place spacers within 24-inches of duct ends. Stagger separators approximately 6 inches between tiers.
3. Minimum Space between Ducts: 3 inches between ducts and between ducts and exterior envelope wall.

K. Concrete-Encased Ducts:

1. Secure separators to earth and to ducts to prevent floating during encasement. Tie entire assembly together using non-ferrous tie-wires or straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Reinforcement: Where indicated, reinforce concrete-encased duct banks for their entire length. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
3. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
4. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct and exterior envelope wall.
5. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

6. Concrete Encasement:

a. Use normal strength concrete, minimum 3000 psi at 28 days, 6 to 8 inch slump, with maximum 1/2 inch aggregate.
b. Comply with requirements in "Concrete Placement" Article in Division 03. Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope.
c. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces.
d. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

7. Complete final backfilling after concrete has cured.

L. Direct-Buried Duct Banks:

1. Set elevation of bottom of duct bank below frost line.
2. After installing first tier of ducts, install initial backfill and compact.
3. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process.
4. Perform initial backfilling/encasement in 2-inch lifts. Compact to 95% standard proctor density.
5. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over ducts and hand tamp.
6. Firmly tamp initial backfill around ducts to provide maximum supporting strength. Use hand tamper only.
7. After placing initial backfill over final tier, make final duct connections at end of run and complete backfilling.
8. Initial backfill/encasement material shall be crushed stone, sand, or pea gravel with a maximum aggregate size of 1/2-inch.

M. Warning Tape: Bury warning tape approximately 12 inches above all ducts. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

N. Install pull tape in all spare ducts with 3ft of slack tied off and secured at each pull point.

O. Duct Sealing:

1. Provide temporary plugs of all ducts upon completion of each portion of work to prevent ingress of foreign material into the duct.
2. After conductors have been installed seal all ducts, including spare ducts, at building entrances and equipment terminations. Use sealing compound and foam plugs capable of withstanding at least 15-psig hydrostatic pressure.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

C. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

E. Hardware: Turn over removable hardware, including pulling eyes, cable stanchions, cable arms, to Construction Manager for use during next phase.

F. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install hand-holes and boxes level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a12-inch thick level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade. Install handholes and boxes with bottom below frost line.

D. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

E. For enclosures installed in asphalt paving, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Division 03, with a troweled finish.
2. Dimensions: minimum 10 inches wide and 12 inches deep or as shown on drawings.

3.7 GROUNDING

A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems".

1. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, 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 #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 insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
2. Grounding Connections to Manhole Components: Bond 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 #4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.8 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems"

1. Where ducts transition through manholes or handholes, and at each termination point, provide each duct with a unique identifier to indicate origination point.
2. Cover legends shall be consistent with the owner's standard practices, especially within existing facilities, unless otherwise require by codes.

3.9 FIELD QUALITY CONTROL

A. Prior to covering duct or underground structures, perform visual inspections to verify the following:

1. Proper installation depths and slopes have been maintained.
2. Proper vertical and horizontal spacing in multi-duct formations.
3. All conduit sections have been properly jointed.
4. Proper bend radius of curved sections have been maintained.
5. Check for damage at changes in grades or at bends.

B. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for duct deflections or out of round conditions. Provide a

minimum 6-inch- long mandrel 1/2-inch smaller in diameter than diameter of duct. If obstructions are discovered, remove obstructions and retest.

C. Correct deficiencies, replace affected duct sections, and retest as specified above to demonstrate compliance.

D. Prepare detailed test and inspection reports with accompanying digital photographs.

E. Concealed Work Photographs: Before proceeding with installing backfill that will conceal work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work.

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of all ducts until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes and handholes, including sump. Remove dirt and foreign material.

END OF SECTION

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment Nameplates.
2. Cable and Conductor Labels.
3. Wiring Device Labels
4. Safety Labels.
5. Instruction Signs.
6. Miscellaneous identification products.

B. Related Requirements

1. Refer to Section 260573, "Power System Studies" for additional requirements related to fault current and arc flash labeling.
2. Refer to Section 270553, "Identification for Communications Systems" for additional requirements related to labeling of communications equipment and cabling.

1.3 REFERENCES

A. Abbreviations

B. Definitions

1. Emergency Systems: Those systems legally required and classed as emergency by NFPA 70 Article 700, municipal, state, other codes, or by any government agency having jurisdiction.
2. Essential Electrical Systems: Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. American National Standards Institute (ANSI)
    a. ANSI Z535.4, "Product Safety Signs and Labels"
2. National Fire Protection Association (NFPA)

a. NFPA 70E, "Standard for Electrical Safety in the Workplace"

3. Occupational Safety and Health Administration (OSHA)
   a. 29 CFR 1910.144, "Safety color code for marking physical hazards"
   b. 29 CFR 1910.145, "Specifications for accident prevention signs and tags"
4. Underwriters Laboratories Inc (UL)
   a. UL 969, "Marking and Labeling Systems"

1.4 SUBMITTALS

A. Product Data: For each electrical identification product indicated.
   1. Include project specific examples of each label type.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Closeout Submittal:
   1. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
      a. Provide electronic Excel files of all panelboard directories to owner as part of Close-out Documentation.

1.5 COORDINATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes and standards. Use consistent designations throughout Project.

B. All identifications shall be consistent with the owner's standard practices, especially within existing facilities, unless otherwise require by codes. Where the requirements herein are in conflict, the contractor shall notify the engineer in writing prior to ordering any material.

C. All room names and/or numbers for labeling or programming shall use the Owner's approved room name and numbering scheme, not names and numbers indicated on floor plans. All reprogramming shall be included as required to accommodate construction phasing.

D. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

E. Coordinate installation of identifying devices with location of access panels and doors.

F. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT SIGNS AND NAMEPLATES

A. Engraved Plastic Signs and Nameplates.

1. 3-layer melamine plastic laminate
2. Weather and UV-resistant for Wet and Damp Locations.
3. Thickness:
    a. For signs up to 20 sq. in., minimum 1/16 inch thick.
    b. For signs larger than 20 sq. in. or 8 inches in length, 1/8 inch thick.
    c. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
    d. Framed with mitered melamine molding and arranged for attachment at applicable equipment.
4. Color: Comply with color legend.

2.2 RACEWAY AND CONDUCTOR LABELS

A. Raceway Labels: Pre-printed, self-adhesive, polyester, suitable for indoor or outdoor use, resistant to abrasion, humidity, and weather.

1. Color: Black Letters on an orange field.
2. Size: For each raceway size, comply with ANSI/ASME A13.1 for recommended letter height and field length.

B. Wire and Cable Labels: Machine printed, self-adhesive, polyester, self-laminating, suitable for indoor or outdoor use on flexible cables, resistant to abrasion, humidity, and weather.

2.3 SAFETY SIGNS AND LABELS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. All field-applied hazard markings shall warn of hazards using effective words, colors, symbols, or any combination thereof as recommended by ANSI Z535.4-2011. This applies to all instances where caution, warning, or danger signs are required per the NEC and applicable OSHA standards.

C. Self-Adhesive Safety Labels: Polyester, Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for intended use and suitable for installed environment.

D. Provide UV overlaminating film for outdoor locations.

2.4 INSTRUCTION SIGNS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Floor Marking Tape: 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

B. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system suitable for surface material and location (exterior or interior).

C. Fasteners for Labels and Signs:

1. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.
2. Pop-Rivets.
3. Two-Part Epoxy Adhesive

D. Cable Ties: Self-extinguishing, one-piece, self-locking, UV-stabilized or plenum rated where required by installed environmental conditions. 3/16-inch minimum width.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Verify identity of each item before installing identification products.

B. Before installation of labels, clean all surfaces using materials and methods recommended by manufacturer of identification device.

C. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

D. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

E. Install all labels in a neat manner, plumb and parallel to equipment lines.

F. Attach plastic signs and labels to equipment with mechanical fasteners appropriate to the location and substrate. Where screws cannot or should not penetrate substrate use two-part epoxy adhesive listed for use with intended substrate and environmental conditions.

G. Hand written, non-permanent, or stenciled labels are not permitted unless noted otherwise.

H. For surfaces that require finish work, apply identification devices to surfaces after completing finish work.

I. Identification shall consist of all UPPER-CASE LETTERS.

J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

3.2 EQUIPMENT IDENTIFICATION

A. Provide all new and modified equipment with a nameplate consisting of 1/2" letters for equipment designation and 1/4" letters for voltage, source, and feeder information. This includes but is not limited to panelboards, switchboards, switchgear, disconnect switches, transformers, power transfer equipment, generators, motor starters, variable frequency drives, lighting control panels, contactors, cabinets, push button stations, and auxiliary system control panels.

B. Distribution equipment labels shall indicate the following:
   1. Equipment designation.
   2. Voltage system.
   3. Equipment ampacity.
   4. Source equipment designation and location.
   5. Feeder size.

C. Equipment disconnect labels shall indicate the following:
   1. Equipment designation.
   2. Voltage system and feeder ampacity
   3. Source equipment designation and location.

D. Locate equipment nameplates at center of top of trim for branch circuit panels, switchgear, and centered at side for branch circuit switches.

E. Where equipment is provided with a factory installed disconnecting means or motor controller, install label on factory provided unit.

F. For equipment with multiple power sources, such as transfer switches and control panels, identify each source and its function.

G. Color Legend
   1. Normal Power Systems: Black field with white letters

H. Where electrical distribution equipment, including panelboards, switchboards and switchgear, are connected to an emergency source, the nameplate shall incorporate the word "EMERGENCY" into the legend. Refer to drawings for further details.

I. Where the premise wiring system has feeders and/or branch circuits supplied from more than one nominal voltage system, provide sign at each switchgear, switchboard, and panelboard displaying color coded identification method for each ungrounded, grounded, and equipment grounding conductor.

J. Service Equipment and Building Feeder, Branch Circuit Disconnects.
   1. Provide label for service disconnecting means to permanently identify it as the “SERVICE DISCONNECT”.
   2. Where a building or structure has any combination of feeders, branch circuits, or services passing through it or supplying it, provide a permanent sign at each disconnect location identifying all other feeders, branch circuits, or services and the area served by each.

3.3 IDENTIFICATION OF CONDUCTORS

A. Service, Feeder, and Branch-Circuit Conductors: Refer to Section 260519, “Low Voltage Electrical Power Conductors and Cables” for conductor and cable color coding requirements.

B. Indicate source and circuit number of conductors to be extended in the future.

C. Auxiliary Systems Alarm, Signal, and Control Wire Identification: At termination points, identify each conductor by its system, designation, and function.

3.4 IDENTIFICATION OF RACEWAYS AND BOXES

A. Identify all junction, outlet, device, and pull boxes with wiring system, voltage, and circuit designations of conductors.

1. In concealed locations above accessible ceilings and in exposed unfinished areas such as data, mechanical, or electrical rooms, provide designations on outside of box covers.
2. For exposed boxes in finished areas, provide designations on inside of box covers.
3. System Legend shall be as follows:
    a. Power
    b. Emergency
    c. UPS

B. The inside of all junction and backboxes shall be marked with panel and circuit number in permanent marker.

C. For Essential Electrical Systems, all junction boxes utilized for life-safety branch emergency power circuits, connections, devices, etc. shall have the cover painted blue. Mark over paint with panel and circuit number.

D. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate.

3.5 IDENTIFICATION OF WIRING DEVICES

A. All new and existing receptacle cover plates in area of work shall be marked with their panel and circuit number(s) with clear, machine printed adhesive labels with black lettering.

3.6 PANELBOARD CIRCUIT DIRECTORIES

A. For Distribution Panelboards, Switchboards, and Switchgear, provide nameplates at each switch or circuit breaker to indicate load designation.

B. Provide clearly legible typewritten directories in each electrical panel indicating the area, item of equipment, etc. controlled by each switch, breaker, fuse, etc. These directories are to be inserted into plastic cardholders on back door in each panel. Descriptions shall identify each circuit as to its clear, evident, and specific purpose or use. The identification shall include an approved degree of detail that allows each circuit to be distinguished from all others. Spaces and Spare positions shall be described accordingly.

1. At a minimum, provide the following panel information for each panel directory:
    a. Panel name
    b. Panel bus rating
    c. Voltage System
    d. Mains Configuration and Rating
    e. Short Circuit Current Rating
2. Circuit Designation Examples:

a. LIGHTS, ROOM 100
b. FLOOR RECEPTACLES, ROOM 200
c. ERV-1 RECEPTACLE, ROOF

C. Panel Schedules and circuit numbers on Record Drawings shall match.

3.7 SAFETY SIGNS

A. Install Warning, Caution, and Danger signs in accordance with NFPA 70 and OSHA requirements to ensure safe operation of electrical equipment and the items to which they connect.

B. Comply with 29 CFR 1910.145 and ANSI Z535.4.

C. Apply to exterior of door, cover, or other access point.

D. Labels and signs shall include, but are not limited to, the following legends:

1. Identify system voltage with black letters on an orange background.
2. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
3. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES"
4. Where series combination ratings are allowed: "CAUTION - SERIES COMBINATION SYSTEM RATED ____ AMPERES. IDENTIFIED REPLACEMENT COMPONENTS REQUIRED."

3.8 INSTRUCTION SIGNS

A. Operating Instruction Signs: Install instruction signs with minimum 3/8-inch letters to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation, power transfer, and load shedding.

3.9 WORKSPACE INDICATION

A. Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

END OF SECTION

SECTION 260573

POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Section includes the following computer-based studies:

1. Fault-current study to determine the minimum interrupting capacity of circuit protective devices.
2. Overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
3. Arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

B. Related Requirements

1. Refer to Section 260553, "Identification for Electrical Systems" for label material and performance requirements.

1.3 REFERENCES

A. Abbreviations
1. SCCR: Short-circuit current rating.

B. Definitions

1. Emergency Electrical Systems: Those systems legally required and classed as emergency by NFPA 70 Article 700, municipal, state, other codes, or by any government agency having jurisdiction.
2. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
3. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
4. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
5. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
6. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
7. Single-Line Diagram: See "One-Line Diagram."

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. Institute of Electrical and Electronics Engineers (IEEE)

   a. IEEE 141 - Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
   b. IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings
   c. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
   d. IEEE 399 - Recommended Practice for Industrial and Commercial Power System Analysis
   e. IEEE 551 - Recommended Practice for Calculating AC Short-Circuit Currents in Industrial and Commercial Power Systems
   f. IEEE 1015 - Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
   g. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations
   h. IEEE 3002.3 - IEEE Recommended Practice for Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems

2. American National Standards Institute (ANSI)

   a. ANSI C57.12.00 - Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
   b. ANSI C37.13 - Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
   c. ANSI C37.010 - Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
   d. ANSI C 37.41 - Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories

3. The National Fire Protection Association (NFPA)

   a. NFPA 70E - Standard for Electrical Safety in the Workplace

1.4 SEQUENCING

A. The short-circuit and protective device coordination studies shall be submitted for review prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing.

B. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Initial Study Report: The study shall provide sufficient data to ensure that selection of equipment and devices will have adequate ratings and the protective device trip characteristics will be satisfactory. Include the following:

1. Study input data, including completed computer program input data sheets including assumptions on worst case project conditions.
2. Study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

C. Final Study and Report: Submit final study at the end of the construction when all circuits are installed and all equipment is on site and installed such that complete and accurate data can be obtained.

D. Closeout Submittals

1. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:

   a. Provide five (5) bound copies of the complete final report. Additional copies shall be provided on CD or USB in PDF format.
   b. Certification Document to confirm system settings have been implemented.
   c. At the owner's option, provide the study project files in electronic format including all project files and libraries to allow the owner to update and print additional copies, labels, etc.

1.6 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are not acceptable.

D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located and skilled in performing and interpreting the power system studies. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

1. Engineer shall be a full-time employee of the electrical equipment manufacturer.
2. The engineer shall have a minimum of five (5) years' experience performing power system studies.

E. Power System Study Certification: Report shall be signed and sealed by Power Systems Analysis Specialist.

F. Field Adjusting Personnel Qualifications:

1. Technician shall be a full-time employee of the electrical equipment manufacturer.
2. Technician responsible for all field adjusting of the Work shall have a minimum NICET Electrical Power Testing Level III certification or equivalent.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Perform studies using the latest version of Power Tools for Windows by SKM Systems Analysts.

B. Comply with IEEE 242, IEEE 399, IEEE 551, IEEE 1584, IEEE 3002.3, and NFPA 70E.

C. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.2 POWER SYSTEM STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
6. Derating factors and environmental conditions.
7. Any revisions to electrical equipment required by the study.

D. Study Input Data

1. Available Power source data.
2. Manufacturer, model, and interrupting rating of protective devices.
3. Conductors.
4. Transformer data.

E. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment SCCR ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that SCCR ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
    a. Voltage.
    b. Calculated fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Calculated asymmetrical fault currents:
        1) Based on fault-point X/R ratio.
        2) Based on calculated symmetrical value multiplied by 1.6.
        3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. No AC Decrement (NACD) ratio.
    e. Equivalent impedance.
    f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
    a. Phase and Ground Relays:
        1) Device tag.
        2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
        3) Recommendations on improved relaying systems, if applicable.
    b. Circuit Breakers:
        1) Adjustable pickups and time delays (long time, short time, and ground).
        2) Adjustable time-current characteristic.

3) Adjustable instantaneous pickup.
4) Recommendations on improved trip systems, if applicable.

2. Fuses: Show current rating, voltage, and class.

I. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
   a. Power utility's overcurrent protective device.
   b. Medium-voltage equipment overcurrent relays.
   c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
   d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
   e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
   f. Cables and conductors damage curves.
   g. Ground-fault protective devices.
   h. Motor-starting characteristics and motor damage points.
   i. Generator short-circuit decrement curve and generator damage point.
   j. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Maintain selectivity for tripping currents caused by overloads.
6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

J. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. No AC Decrement (NACD) ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
   g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

K. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.

2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

2.3 ARC-FLASH WARNING AND AVAILABLE FAULT CURRENT LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each location indicated in the analysis unless noted otherwise.

B. Arc Flash Warning Labels shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include all information required by NFPA 70E and the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Engineering report number, revision number, and issue date.

C. Available Fault Current Labels shall have an orange header with the wording, “WARNING”, and shall include the following information taken directly from the short circuit study.

1. Location designation.
2. Maximum available fault current.
3. Calculation date.
4. Engineering report number, revision number, and issue date.

D. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the study.

1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Engineer's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Electrical Survey Data: Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required

to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study. Data includes, but is not limited to, the following:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical power utility impedance and available short circuit current at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Derating factors.
16. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:
    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
    k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.2 POWER SYSTEMS STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Base study on device characteristics supplied by device manufacturer.

C. Gather all necessary data from the existing facility as needed to perform the study.

D. The Contractor shall be responsible for modifying settings on existing equipment only at over-current protection devices upstream of new equipment unless noted otherwise.

E. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

F. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

G. Identify in the report any protective device applied outside its capacity.

H. Short Circuit Study

1. Calculate short-circuit currents according to IEEE 551.
2. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
    a. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
3. Evaluate equipment and protective devices and compare to short-circuit ratings.

I. Coordination Study

1. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
2. Transformer Primary Overcurrent Protective Devices:
    a. Device shall not operate in response to the following:
        1) Inrush current when first energized.
        2) Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
        3) Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
    b. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
3. Motor Protection:
    a. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
    b. Select protection for motors served at voltages more than 600 V according to IEEE 620.
4. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

5. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

J. Arc Flash Hazard Analysis

1. Comply with NFPA 70E and its Annex D for hazard analysis study.
2. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.
3. Calculate maximum and minimum contributions of fault-current size.
   a. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
   b. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
4. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
5. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.
6. Calculate the limited, and restricted approach boundaries for each location.
7. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
   a. Fault contribution from induction motors shall not be considered beyond three to five cycles.
   b. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
8. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
   a. When the circuit breaker is in a separate enclosure.
   b. When the line terminals of the circuit breaker are separate from the work location.
9. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 LABELING

A. All labels will be based on recommended overcurrent device settings and will be provided to owner after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system.

B. Arc Flash Labeling:

1. Provide and install an arc-flash label for each piece of electrical equipment listed below and each piece of equipment that is likely to require examination, adjustment, servicing, or maintenance while energized:
   a. Motor-control centers.
   b. Switchboards.
   c. Switchgears.
   d. Meter Enclosures.
   e. Medium voltage and low volage transformers

f. Panelboards.
g. Equipment Control panels.
h. Motor Controllers.
i. Disconnect Switches.

2. Apply arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

C. Available Fault Current Labeling

1. Provide and install an available fault current label for each piece of electrical equipment listed below:

a. Service equipment.
b. Elevator Control Panel.

D. Install warning labels under the direction of the Power System Analysis Specialist.

E. Provide new labels for any existing equipment to remain with updated values based on the results of the analysis.

3.4 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by a qualified technician from the engineering service division of the equipment manufacturer.

B. Make modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Notify Architect and Engineer in writing of any required major modifications.

D. Equipment shall not be energized until all breakers or protective relays are set either to the recommended values indicated by the studies or to minimum trip settings.

E. Certification: Prior to project Substantial Completion, submit four signed copies of a document certifying that the settings and selection scope has been completed as specified.

3.5 DEMONSTRATION

A. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.

B. Hand-out and explain the power system study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.

C. Arc Flash Training

1. Train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels (minimum of 4 hours).

2. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.
3. Include in Project Close-out Documents training notes, outlines, and Power Point presentation of training session. Also include attendance record of personnel attending the training session.
4. Training session shall be videotaped. Include copy of DVD of training session in Project Close-out Documents.

END OF SECTION

SECTION 260923

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Description:

1. Section includes requirements for the provision of Lighting Controls including manufacturing, fabrication, configuration and installation as required for the complete performance of the Work, as shown on the Drawings, as specified herein.
2. This work consists of providing all labor, materials, accessories, mounting hardware and equipment necessary for an operationally and aesthetically complete installation of all lighting controls.
3. Specifications and drawings are intended to convey all salient features, functions and characteristics of the lighting control devices only, and do not undertake to illustrate or set forth every item or detail necessary for the work. Minor details, not usually indicated on the drawings nor specified, but that are necessary for proper execution and completion of the lighting controls shall be included, the same as if they were herein specified or indicated on the drawings.

B. Section Includes:

1. General lighting control devices
2. Digital lighting control devices
3. Lighting Contactor Cabinets
4. Electronic Digital Time Switches
5. Outdoor Photoelectric Switches
6. Emergency lighting control devices

C. Related Requirements:

1. Refer to Section 260500, "Common Work Results for Electrical Systems" for requirements related to equipment supports.
2. Refer to Section 262726, "Wiring Devices" for requirements related to lighting snap switches and wall plates.

1.3 REFERENCES

A. Abbreviations and Acronyms

1. BAS: Building Automation System.
2. DDC: Direct Digital Controller/Direct Digital Control.
3. IP: Internet protocol.
4. NRTL: Nationally Recognized Testing Laboratory

5. SPD: Surge Protection Device

B. Definitions

1. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100 and ANSI/IES LS-1.
2. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
3. Zone: A light fixture or group of light fixtures controlled simultaneously as a single dimmer/relay/entity.
4. Occupancy Sensor: Motion sensing device programmed as automatic on and automatic off.
5. Vacancy Sensor: Motion sensing device programmed as manual on and automatic off.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. National Electrical Contractors Association (NECA):
   a. NECA NEIS 130, "Standard for Installing and Maintaining Wiring Devices"
2. Underwriters Laboratories, Inc. (UL):
   a. UL 508, "Standard for Industrial Control Equipment."
   b. UL 773, "Plug-in, Locking Photocontrols for Use with Area Lighting."
   c. UL 773A, "Nonindustrial Photoelectric Switches for Lighting Control."
   d. UL 916, "Standard for Energy Management Equipment Systems."
   e. UL 917, "Clock Operated Switches."
   f. UL 924, "Emergency Lighting and Power Equipment."
   g. UL 1008, "Transfer Switch Equipment."
   h. UL 1449, "Transient Voltage Surge Suppressors."
   i. UL 2108, "Low-Voltage Lighting Systems."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated including physical data and electrical performance. Include data on features, accessories, finishes, and the following:

1. Physical description, including dimensions.
2. All available finishes and colors for each device and wall/cover plate shall be submitted to the Architect for selection during review.
3. Control type: 0-10V, DMX, bi-level, etc.
4. Sample Warranty.

B. Shop Drawings: Show installation details for occupancy, vacancy, light-level sensors, and digital control devices.

1. Lighting floor plan showing location, orientation, and coverage area of each wall and ceiling mounted sensor.
2. Interconnection diagrams showing field-installed wiring.
3. Riser diagrams indicating device network and cabling types.
4. Include systems descriptions, set points, and controls settings and adjustment.

C. Manufacturer's Installation Instructions: Include for manufactured components.

D. Control Schedules: After confirming with owner, list operating hours for each day of the week, include observed holidays.

E. Qualification Data: For Start-Up Field Technician

F. Closeout Submittals

1. Operation and Maintenance Data: For each type of product to include in operation and maintenance manuals. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
    a. Description of operation and servicing procedures.
    b. Technical support contact
    c. List of components.
    d. Recommended spare parts.
    e. Programming instructions and system operation procedures.
    f. Include interconnection wiring diagrams complete field installed system with identified and numbered, system components and devices.
    g. Include operation and maintenance manuals for equipment and devices, including sensors, power supplies, and other equipment furnished.
    h. Provide detailed set-up information for furnished equipment, indicating required initial configuration switch settings, jumper positions, to facilitate equipment replacement.
    i. Include device calibration settings after system programming and start-up with manufacturer's representative.
2. Software and Firmware Operational Documentation:
    a. Software operating and upgrade manuals.
    b. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
    c. Device address list.
    d. Printout of software application and graphic screens.

1.5 MAINTENANCE MATERIAL

A. Extra Stock Material: Provide one (1) of each type of sensor, switch, dimmer, power pack, and emergency lighting control device installed. Package with protective covering for storage and identified with labels describing contents.

B. Keys and Special Tools: Provide one extra set for access to locked or tamperproof enclosures.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Manufacturer must maintain an authorized service organization within 100 miles of the project location that stocks a full complement of parts for all equipment specified in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
2. Provide toll free technical telephone support.

B. Installer Qualifications:
1. An employer of workers qualified and trained in electrical safety as required by NFPA 70E.

C. Start-Up Field Technician Qualifications:
1. Minimum experience of 2 years training in the electrical/electronic field.
2. Certified by the manufacturer on the system installed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer instructions for storage of equipment and devices to prevent damage from dirt, moisture, or other environmental concerns.

1.8 COORDINATION

A. Preinstallation Conference: Arrange a pre-installation conference between all applicable subcontractors and architect/engineer prior to the installation of rough-ins for the lighting controls.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, speakers, fire alarm, HVAC equipment, fire-suppression system, and partition assemblies.

C. Coordinate protocol and interface points of lighting control devices with temperature controls (BAS/DDC) specified in Division 23.

D. Product procurement and coordination:

1. Order products according to application.
2. Confirm the proper and complete catalog number with distributor and agent.
3. Provide additional parts and pieces required to complete the installation in the location and manner intended by the design.
4. Confirm voltages.

E. Contractor shall coordinate with Vendors and other trades, in advance of installation work, to define all infrastructure and installation requirements. Contractor shall coordinate all infrastructure requirements with all approved lighting control devices prior to infrastructure installation. This includes, but not limited to, appropriately sized, positioned, and located junction boxes, structural supports, feeds, power conduits, control conduits, and remote code-compliant power-supply enclosures.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace lighting controls, finishes, wiring, cabling and all of its components that fail in materials or workmanship within 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70, as well as applicable ANSI, IEC standards, and FCC regulations.

C. Comply with CFR Title 47, Part 15, Subparts A and B, for Class A digital devices.

D. Devices shall be in accordance with NFPA 70, NEMA, and UL listed and labeled.

E. RoHS compliant.

F. Devices located in above ceilings shall be plenum rated.

G. Power failure: Incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost and should restore system to its last operating state without requiring user input.

H. Failsafe operation: If automatic switching device loses power, device will latch to closed "ON" position.

I. Components shall be designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.

J. Products tested in identical manner, complaint to NEMA WD 7 -2011 Occupancy Motion Sensors Standards.

K. Voltage: 120/277VAC unless noted otherwise

L. Line-Voltage Surge Protection: Include in all 120- and 277-V solid-state equipment. Comply with UL 1449 and with ANSI C62.41 for Category A locations.

M. Refer to Section 262726 "Wiring Devices" for device and faceplate colors.

N. Standard Operating Range: 32 to 120 deg F, up to 90 percent relative humidity, non-condensing, unless noted otherwise.

O. Minimum load rating: 800W at 120VAC and 1200W at 277VAC.

P. Provide all control devices with LED status indicator.

Q. Minimum Occupancy and Vacancy Sensor Coverage Radius:

1. Wall Switch: 35 ft for large motion, 20 ft for small motion.
2. Ceiling, 360 deg, Standard Range: 12 ft radius for small motion.
3. Ceiling, 360 deg, Extended Range: 28 ft radius for large motion.
4. Corner, 120 deg: 40 ft for large motion.
5. Hallway: 100 ft for large motion.
6. High Bay, 360 deg: 20 ft radius at 15 ft mounting height for large motion

2.2 GENERAL LIGHTING CONTROL DEVICES

A. Basis of Design: Subject to compliance with requirements, provide products indicated on Drawings or equivalent by one of the following:

1. Acuity Sensorswitch
2. Hubbell
3. Leviton
4. Lutron
5. Wattstopper

B. General Requirements:

C. Wall Switch Occupancy and Vacancy Sensors: Decora style sensor with on/off switch(es) for mounting in a single gang switchbox.

1. Programmable Automatic On and Manual On Operating Modes.
2. Time Delay for Automatic Off: Adjustable up to 20 minutes.
3. Programmable sensitivity settings.
4. Sensing Technology: Dual technology, PIR and Ultrasonic or Microphonics unless noted otherwise.

5. Noise filtering to eliminate false triggers.
6. Vandal resistant lens
7. Multi-Way: Multi-way: Capable of operation in 3-way application where indicated.
8. Dimming: Provide 0-10V dimming output where indicated.
9. Dual Relay: Where independent control of two loads is required, provide unit with two isolated relays and override switches, capable of independent operating modes and time delays.

D. Line Voltage Occupancy Sensors: Self-contained occupancy sensor with integral power supply and relay suitable for mounting to a standard outlet box in ceiling and wall mounted applications

1. Automatic On operation.
2. Time delay for Automatic Off: Adjustable up to 20 minutes.
3. Sensing Technology: Dual technology, PIR and Ultrasonic or Microphonics unless noted otherwise.
4. Dual Relay: Where independent control of two loads is required, provide unit with two isolated relays and override switches, capable of independent operating modes and time delays.

E. Low Voltage Occupancy, Vacancy Sensors, Daylight Sensors, Power Packs, and Low Voltage Wall Stations

1. Programmable Automatic On and Manual On Operating Modes.
2. Time Delay for Automatic Off: Adjustable up to 20 minutes.
3. Sensing Technology: Dual technology, PIR and Ultrasonic unless noted otherwise.
4. Noise filtering to eliminate false triggers.
5. Isolated Relay: Low voltage relay with N.O. and N.C. outputs to indicate occupancy status for HVAC interface with BAS/DDC system.
6. Power Packs/Load Controllers: Self-contained power supply with relay module capable of switching 20-amp load.
    a. Class 2, 24VDC output for powering low voltage sensors.
    b. UL 2043 Plenum Rated.
    c. Threaded 1/2-inch nipple, suitable for mounting inside or outside a junction box.
7. Wall stations: Low voltage, decorator style, with single or multiple pushbuttons for interface with power packs and sensors.
    a. Multi-way: Capable of operation in 3-way application.
    b. Manual Dimming: Provide 0-10V dimming output where indicated.
8. Low Voltage Indoor Daylight Sensors: Low voltage, ceiling mounted photosensor that detects changes in light levels.
    a. Suitable for interface with an occupancy/vacancy sensor, power pack, or another field device.
    b. Closed loop device: measures both daylight contribution and controlled electric light contribution.
    c. Open Loop device: measures only daylight contribution.
    d. Desired task level illuminance: Auto calibrating, programmable, with daytime and nighttime on/off setpoints and a dead band to prevent light from cycling.
    e. Auto Dimming: Provide 0-10V dimming output for automatic dimming control of luminaires.

F. Interval Timer Light Switch: Combination countdown timer and conventional switch lighting control unit, switchbox mounted, decorator style.

1. On/Off Switch with Status LED.
2. Adjustable preset intervals.

3. Warning: Audible and/or flash timeout warning.

G. Wallbox Dimmer Switches

1. Single gang decorator style, suitable for full range continuous variable control of luminaire light intensity.
2. Comply with UL 1472.
3. Preset slide style dimming control with a mechanical air-gap switch to totally disconnect power from the load when in the off position.
4. Compatible with luminaire ballast or driver.

2.3 DIGITAL LIGHTING CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products indicated on drawings or equivalent by one of the following:

1. Acuity nLight
2. Crestron Zum
3. Hubbell NX
4. Wattstopper DLM

B. Description: Intelligent control devices capable of operating in standalone control zones or in a networked configuration for remote, time-based, and global operation with inputs from digital signal sources and remote configuration and monitoring through a software interface.

C. System Architecture:

1. Free topology plug-in wiring with green Cat 5e network cabling for power and data between control devices, switches, and sensors.
2. Self-configuring, digitally addressable control devices.
3. Any combination of inputs shall be programmable to any number of control devices.
4. Automatic configuration and connection of room loads to the connected control devices in the space without commissioning or the use of any tools.
5. Units shall not have any dip switches or potentiometers for field settings.

D. Sensors, power packs, and wall stations shall be interconnected through RJ-45 ports and comply with General Requirements section specified herein.

E. System Accessories: Provide the following accessories as required for implementation of the control intent illustrated on the drawings.

1. Daylight Sensors: Shall be digital and comply with General Requirements section specified herein.
   a. Daylight sensor groupings: The set of zones that are controlled by a given daylight sensor shall be configurable through associated lighting relay room controller and shall not require manual wiring to modify.
   b. Daylight sensor settings: Settings associated with a given daylight sensor shall be adjustable through associated lighting relay room controller and shall not require any physical adjustment to the sensor itself.
2. Touchscreen: Customizable LCD capacitive touchscreen for on/off, dimming, zone, and scene control.
3. Handheld Remotes: On/off, dimming, and scene controller using IR communication, provide with wall holster.
4. Wireless Configuration Tools: Handheld remote for device setting programming, two-way IR communication.

5. I/O Module: Input / Output device. 24VDC relay with normally open, normally closed, and common outputs to indicate occupancy or lighting status to third party systems such as a BAS. Four input terminals for maintained or momentary switch closure inputs.
6. Serial Data Interface: Provides RS-232 interface with third party AV and/or shade control systems.
7. BACnet Appliance: Provides BACnet MS/TP digital networked communication between rooms, panels, Gateway, or BAS and automatically creates BACnet objects representative of connected devices.
8. IP Gateway: BACnet to ethernet interface to allow web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
9. Programming and Configuration Software: PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.

F. Sequence Control and Override: Networked systems utilizing astronomical or time of day controls shall comply with the following.
1. Override control must allow any relay connected to it to be switched on or off by a manual switch or by an automatic switch, such as a sensor. Provide 2-hour override unless otherwise noted.
2. Override control "blink warning" must warn occupants approximately five minutes before actuating the off sequence. Does not apply to exterior lighting.
3. Activity log, storing previous relay operation, including the time and cause of the change of status.

2.4 LIGHTING CONTACTOR CABINETS

A. Basis of Design: Subject to compliance with requirements, provide product indicated or equivalent product by one of the following:

1. Asco
2. Eaton
3. Square D

B. Description: Factory-wired and tested, lighting control cabinet with contactors, controls, and accessories in single enclosure.

C. Contactors: Electrically operated, dual acting single solenoid mechanism, mechanically held in both open and closed positions, combination-type remote control lighting contactors, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: 30A up to 600VAC.
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Visual position indicator.
4. Control Coil Voltage: Match control power source.
5. Provide contactor capacity and configuration as required to accommodate switched zones shown on drawings plus 4 spares.

D. Control Modules: Solid State interface module, start/stop, two-wire, or three-wire control, mounted directly to contactors.

1. Integral auxiliary SPDT contacts to indicate position of the contactor.

2. Provide solid state control modules as necessary to interface with BAS/DDC systems, timers, photoelectric switches and similar control devices as required by lighting control zones and sequences.

E. Enclosure: Comply with NEMA 250, Steel, NEMA 1 enclosure with hinged lockable cover cabinet enclosure sized as required for components, unless otherwise indicated. Mount switches and indicating lights required on front of enclosure. Install terminal strips for connection of all external control wiring connections. Surface or flush mounted as shown on drawings.

F. Provide the following integral control and indicating devices:

1. Hand-off-auto (HOA) selector switch, of the heavy-duty "oil-tight", maintained-contact type, mounted on the front cover with legend plate.
2. Auxiliary SPDT contacts to indicate position of HOA switch.
3. Auxiliary relay to convert maintained-contact type control circuit to momentary-contact type control circuit necessary for contactor control.
4. Control transformer with primary voltage as indicated and 120-volt, single phase, 60 hertz secondary including fuse and fuse holder.
5. Green and Red pilot lights to indicate "Power ON" and "Power OFF" condition. Mount on front cover with legend plate.
6. Time Clock: Integral 365-day/7-day digital time clock with LCD display.
7. Photocell: Compatible with control voltage and complies with Outdoor Photoelectric Switches section specified herein.
8. Interface with BAS/DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.
   a. Monitoring: Contactor On-off status, HOA switch On, HOA switch Auto.
   b. Control: Contactor On-off operation.

2.5 ELECTRONIC DIGITAL TIME SWITCHES

A. Basis of Design: Subject to compliance with requirements, provide product indicated or equivalent product by one of the following:

1. Intermatic
2. Tork

B. Description: Electronic, solid-state programmable units with alphanumeric display complying with UL 916 and UL 917.

1. Contact capacity and configuration as required to accommodate switched zones and loads shown on drawings.
2. Contact Rating: 30-A, 120/277-VAC.
3. Operating Temperature: -40 to 155 deg F.
4. Enclosure: Steel, NEMA 3R outdoor, lockable.
5. Schedule: Astronomic 7-day/365-day dusk to dawn scheduling with up to 48 on and 48 off events per week and an annual holiday schedule that overrides the weekly operation on holidays.
6. Automatic daylight savings time changeover.
7. Adjustable switching configurations for simultaneous, independent, or pulse control of contacts.
8. 2-hour override buttons.
9. Backup power: Minimum 100-hour time and date retention.
10. Nonvolatile memory, to maintain programming after power loss.
11. USB connection for uploading, downloading and transferring of programs

2.6 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturer: Subject to compliance with requirements, provide product by one of the following:

1. Intermatic
2. Tork
3. Precision

B. Description: Solid state, 120-277VAC, with SPST dry contacts rated for 1800-VA, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: Fifteen second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor.
4. Mounting: Base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
5. Enclosure: Outdoor weathertight housing, resistant to high temperatures, equipped with sun-glare shield, ice preventer, and directional lens to prevent fixed light sources from causing turn-off.
6. Failure Mode: Luminaire stays ON.

2.7 EMERGENCY LIGHTING CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bodine
2. Dual-Lite
3. LVS
4. Wattstopper

B. Automatic Load Control Relays (ALCR)

1. Operation: Automatically switch emergency lighting on and off as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.
2. UL 924 listed device with relay switching circuitry, test switch, normal power indicator light, and an alternate power indicator light in a single enclosure.
3. Universal Input Voltage: 120-277V, 60Hz
4. Load Rating: 20A
5. Suitable for indoor or damp locations.

C. Branch Circuit Emergency Lighting Transfer Switches (BCELTS)

1. Operation: Automatically switch a lighting load from a normal source to a designated emergency source when normal power is lost.
2. UL 1008 listed device with relay switching circuitry, test switch, normal power indicator light, and an alternate power indicator light in a single enclosure.
3. Universal Input Voltage: 120-277V, 60Hz
4. Load Rating: 20A
5. Suitable for indoor or damp locations.

2.8 CONDUCTORS AND CABLES

A. Wiring to supply side of remote-control power sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519, Low-Voltage Electrical Power Conductors and Cables

B. Low-voltage control cable for 0-10VDC dimming: Manufacturer's standard multi-conductor cable with stranded-copper conductors not smaller than No. 18 AWG, plenum rated unless otherwise recommended by the manufacturer.

C. Class 1 and 2 Control Cables: Multi-conductor cable with copper conductors not smaller than No. 14 AWG, plenum rated unless otherwise recommended by the manufacturer.

D. UTP cabling: Unshielded, plenum rated, Cat5e twisted-pair cable. Comply with lighting control system manufacturer's recommendations.

2.9 SOURCE QUALITY CONTROL

A. Factory Tests and Inspections: Perform full-function testing on 100 percent of all system components and panel assemblies at the factory prior to delivery.

B. System control components shall be certified by the manufacturer to have been designed, manufactured and tested for interoperability.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices and equipment before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls, ceilings, and other mounting surfaces for suitable conditions where lighting control devices and equipment will be installed.

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

3.2 INSTALLATION

A. Install lighting controls and equipment in accordance with manufacturer's written instructions, applicable requirements of NEC, and NECA 500 and 501.

B. Electrical installations shall conform to and meet IEEE C2, NFPA 70, and to the requirements specified herein.

C. Devices and Equipment shall be installed and programmed to meet the control intent.

D. Device Installation:

1. Comply with Section 262726 "Wiring Devices" for wall mounted device and faceplate installation requirements.
2. Install in a single box and provide a single cover plate where two or more devices are shown adjacent on plans. Provide voltage barrier where required.
3. Verify door swings with door frame installed prior to rough-in for switches and sensors. Locate switches on latch side of door.
4. Device Orientation: Install switches and dimmers with the "OFF" position down.

E. Panels and Cabinets:

1. Install panels and cabinets in accordance with NECA 407.
2. Mount top of trim no greater than 90-inches above finished floor unless otherwise indicated.
3. Mount panel cabinet plumb and rigid without distortion of box.
4. Install filler plates in unused spaces.

F. Conductors/Wiring:

1. Wiring Methods: Comply with Section 260519, Low-Voltage Electrical Power Conductors and Cables.
2. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
3. Voltage Drop: Adjust conductors and conduit sizes accordingly based on actual field installed conditions.
4. Where the total conductor length for 0-10VDC dimming applications exceeds the values below, adjust conductor size as noted.
   a. Conductor lengths up to 300 feet: #18 AWG minimum.
   b. Conductor lengths between 300 feet and 430 feet: #16 AWG minimum.
   c. Conductor lengths between 430 feet and 690 feet: #14 AWG minimum.
   d. Conductor lengths between 690 feet and 1100 feet: #12 AWG minimum.
   e. Conductor lengths between 1100 feet and 1750 feet: #10 AWG minimum.
5. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
6. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
7. Provide plenum-rated cable, where installed exposed or in open cable tray, within environmental airspaces, including plenum ceilings.

G. Lighting Controllers/Power Packs:

1. Room controllers shall be surface mounted in accessible ceiling space above entry door. Install no higher than 6" above accessible ceiling.
2. Install controllers/power packs on the unswitched line side of local switches to keep sensors powered at all times.
3. Provide controllers/power packs(s) for each room/area/control zone for a working system.
4. Note all power pack locations and branch circuiting on as-built record drawings.

H. Lighting Contactors

1. Install lighting contactors as indicated on plan. Install at accessible locations.
2. Mount contactors in a manner to eliminate structure-borne vibration

I. Occupancy and Vacancy Sensors

1. Provide quantity of sensors indicated as a minimum. Provide additional units to give full coverage over controlled area. Provide full coverage for hand and arm motion detection in office, classroom, and administration type areas and walking motion for storage rooms and hallways.
2. Install wallbox sensors at switch height indicated on drawings,
3. Install wall sensors without manual switches at 8 ft above finished floor unless otherwise noted on drawings.
4. Install ceiling mounted sensors at locations indicated on manufacturer's shop drawings. Sensor manufacturer shall provide quantity of sensors as required to provide complete coverage for rooms.
5. Locate sensors such that motion through open doors will not falsely activate sensors.
6. Do not locate ultrasonic sensors within six feet of supply air diffusers.

7. Locate infrared sensors to avoid obstructions.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

1. Identify all components and power and control wiring.
2. Label time switches and contactors with a unique designation.
3. Provide directories inside relay panels and contactor cabinets that identify each relay and the associated control zone.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform system start-up, functional testing, and inspection of components, assemblies, and equipment installations, including connections.

B. Visual and Mechanical Inspections:

1. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted.
2. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.

C. System Start-up:

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Confirm layout and location of sensors with manufacturer's recommendations to achieve proper coverage of indicated areas. Provide additional sensors and control units as required to achieve complete minor motion coverage of the space indicated. Provide customizable sensor masks to block off unwanted viewing areas.
3. Confirm control schedules with owner including operating hours for each day of the week and holiday schedules. Submit to design team for approval.
4. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

D. System Functional Tests: After installing all control devices, automatic time switches, and sensors, and after electrical circuitry has been energized, test systems for compliance with approved sequences in accordance with energy code requirements.

1. Adjust time delays, trim settings, dead bands, and scene settings.
2. Owner and architect/engineer shall be present during adjustment of scene settings. Exterior scenes shall be adjusted during non-daylit hours.
3. Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
4. Include testing of devices under conditions that simulate actual operational conditions including occupied and unoccupied states.
5. Verify all emergency lighting functions upon loss of power.
6. Record all control settings, operations, cues, and functional observations.

E. Nonconforming Work:

1. Lighting control devices and equipment will be considered defective if it does not pass tests and inspections.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace defective units and retest.
3. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

B. The lighting and lighting controls systems shall be synchronized and fully operable to address the lighting operation in a complete and code-compliant manner.

C. All ladders, scaffolds, lifts, gloves, cleaning cloths, access/adjustment tools, etc. required for aiming and adjusting lighting controls shall be furnished by the Contractor.

3.6 PROTECTION

A. Install lighting control devices after all wall preparation, including painting, is complete.

B. Replace all devices that have been in temporary use during construction and that were installed before building finishing operations were complete.

C. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

D. Do not remove surface protection, such as plastic film and smudge covers, until final cleaning has been completed.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's facility management and maintenance personnel, and selected Owner representatives. as specified below:
1. Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of four (4) hours training.
2. Training Aid: Use the approved final version of maintenance manuals as a training aid.
3. Training shall include, but not be limited to, overview, adjustment, operation, use, maintenance, and demonstration of the lighting control system.

B. Software Service Agreement

1. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
    a. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

END OF SECTION 260923

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Description: Section includes requirements for the provision of Panelboards including manufacturing, fabrication, configuration and installation as required for the complete performance of the Work, as shown on the Drawings, as specified herein.

B. Section Includes:

1. Distribution panelboards
2. Lighting and appliance branch-circuit panelboards
3. Disconnecting and overcurrent protective devices.

C. Related Requirements:

1. Refer to Section 260500, "Common Work Results for Electrical Systems" for requirements related to equipment supports.

1.3 REFERENCES

A. Abbreviations

1. AFCI: Arc-fault circuit interrupter.
2. GFCI: Ground-fault circuit interrupter.
3. GFPE: Ground-fault protection of equipment.
4. MCCB: Molded Case Circuit Breaker
5. SWD: Switching Duty
6. VPR: Voltage protection rating.

B. Definitions

1. Panelboard: A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. National Electrical Contractors Association (NECA):
    a. NECA 407, “Standard for Installing and Maintaining Panelboards"
2. National Electrical Manufacturers Association (NEMA):
    a. NEMA AB 1, "Molded Case Circuit Breakers and Molded Case Switches."
    b. NEMA PB 1, "Panelboards."
    c. NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."
3. Underwriter Laboratories (UL):
    a. UL 50, "Enclosures for Electrical Equipment, Non-Environmental Considerations."
    b. UL 67, "Standard for Panelboards."
    c. UL 489, "Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures."

1.4 SEQUENCING

A. Submit the preliminary power system study prior to receiving final approval of equipment and system protective devices submittals and prior to release of equipment drawings for manufacturing. Adjust equipment sizes, frame sizes, and trip units as necessary to achieve performance requirements outlined in Section 260573, “Power Systems Studies”.

1.5 SUBMITTALS

A. Product Data: For each type of panelboard,
    1. Include materials, switching and overcurrent protective device, accessories, and component indicated.
    2. Include manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
    1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
    2. Detail enclosure types and details for types other than NEMA 250, Type 1.
    3. Detail bus configuration, current, and voltage ratings.
    4. Short-circuit current rating of panelboards and overcurrent protective devices.
    5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
    6. Include wiring diagrams for power, signal, and control wiring.

C. Closeout Submittals
    1. Operation and Maintenance Data: For Panelboards and components to include in operation and maintenance manuals.
    2. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
        a. Routine maintenance requirements for panelboards and all installed components.
        b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices
        c. Time-current coordination curves for each type and rating of overcurrent protective device included in Panelboards.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of qualified workers as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1. Handle carefully to avoid damage to internal components, enclosure, and finish.

B. Comply with manufacturer instructions for storage of electrical equipment to prevent damage from condensation or other environmental concerns.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Distribution equipment sizes and equipment layouts shall be considered basis of design. Equipment sizes vary by manufacturer. If proposed equipment is larger than the sizes illustrated, the burden shall be on the Contractor to provide equipment which fits in the space allotted while maintaining all code-required and manufacturer-recommended clearances.

C. Drawings indicate space available for electrical equipment, including clearances between equipment and adjacent surfaces and other items. Equipment installed must comply with all clearance, access and replacement working space requirements of the NEC and Owner.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards, circuit breakers, finishes, controls, components, and accessories that fail in materials or workmanship within 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB.
2. Eaton.
3. Siemens.
4. Square D.

B. Source Limitations: Obtain panelboards, overcurrent protection devices, and all other electrical distribution equipment through one source from a single manufacturer.

2.2 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70 and NEMA PB 1.

C. Provide circuit breaker type panelboards unless noted otherwise.

D. Enclosures: Flush- or surface-mounted, dead-front cabinets as indicated on drawings.

1. Rated for environmental conditions at installed location.
    a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    b. Outdoor and Wet Locations: NEMA 250, Type 3R.
2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box and keep tight to wall with no gaps allowing access to live parts. Oversize trims will not be acceptable
4. Interior trim shall be of dead-front construction to shield user from all energized parts.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Materials and Finishes:
    a. Panels, Back Boxes and Trim: Galvanized Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Boxes: Galvanized steel with same finish as panels and trim. Unpainted galvannealed steel is not acceptable.
7. Boxes shall have removable end walls. End walls shall not be provided with concentric knockouts. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
8. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
9. All lock assemblies shall be keyed alike.

E. Incoming Mains:

1. Circuit breaker or Lugs only as indicated on drawings
2. Location: Top or bottom to match feeder conduit entry.
3. Feeders routed through the side gutters to reach the top or bottom main breakers from the opposite end of the panel are not acceptable.
4. Main lugs or main breakers shall have barriers on five sides.

F. Phase, Neutral, and Ground Busses:

1. Material: Hard-drawn copper, 98 percent conductivity.
    a. Bus shall be fully rated the entire length, with one continuous bus bar per phase.
2. Phase bussing shall be pre-drilled to accommodate field installable options.

3. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
4. Equipment Ground Bus: Extend full length of panelboard and adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type.
6. Feed-Through Lugs: Where indicated provide mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device. Provide where indicated on drawings.
7. Subfeed (Double) Lugs: Where indicated provide mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus where indicated.

H. Service Entrance: Where panelboards are used as service equipment with one or more main service disconnecting and overcurrent protective devices, provide marking by an NRTL acceptable to authority having jurisdiction indicating panelboard is suitable for use as service equipment. Coordinate with utility company for any additional requirements.

I. Future Devices: Provide mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices. Where panelboards. are noted to have “space” or “space only”, this shall be prepared space with all bussing, lugs, etc. as required to accept future installation of over-current devices.

J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Panelboard and overcurrent protective device short circuit ratings shall be at least 110 percent of the actual available fault current.
1. Panelboards rated 240V or less: minimum 10,000 A.
2. Panelboards rated above 240V: minimum 14,000 A.

2.3 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Provide bolt-on circuit breakers for overcurrent protective devices.

C. Doors: Secured with three point vault-type latch with tumbler lock; keyed alike. For doors more than 48 inches high, provide two latches.

D. All panelboards shall be capable of accepting 225 amp 3 pole branch breakers as a minimum unless otherwise noted.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

C. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

D. All panelboards shall have space to accept forty-two 20 amp single pole circuit breakers unless otherwise noted.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:
   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers:
   a. Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers:
   a. RMS sensing.
   b. Field-replaceable rating plug or field-replicable electronic trip.
   c. Digital display of settings, trip targets, and indicated metering displays.
   d. Multi-button keypad to access programmable functions and monitored data.
   e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
   f. Integral test jack for connection to portable test set or laptop computer.
   g. Field-adjustable Instantaneous, Long- and short-time pickup, and Ground-fault pickup settings.
4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
5. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
6. AFCI Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
7. MCCB features and accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Breaker handle indicates tripped status.
   c. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Shunt Trip: 120 V or 24V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
   f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
   g. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

B. Provide Ground Fault protection for circuit breakers rated 1000 A and higher on solidly grounded wye systems more than 150V to ground.

C. Provide Arc Flash energy reducing maintenance switch with local status indicator for circuit breakers rated 1200A and higher or where circuit breaker trip setting can be adjusted to 1200A or greater.

2.6 METERING

A. Where indicated comply with requirements in Section 260913, "Electrical Power Monitoring."

2.7 SURGE PROTECTION DEVICES

A. Where panelboards are indicated with integral SPD, comply with requirements in Section 264300, "Surge Protective Devices". Factory install SPDs prior to shipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work. Ensure area to receive panelboard has adequate clearance for panelboard installation.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

C. Temporary Lifting Provisions: Remove any temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 90 inches above finished floor unless otherwise indicated or where required to maintain center of trip handle on overcurrent protection devices below 79-inches. Where mounted in groups, align top of trim or tub for all panels in an area.

E. Mount panelboard cabinet plumb and rigid without distortion of box.

F. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Provide steel slotted support structures where required for freestanding equipment or where building mounting surface is unsuitable.

H. Install overcurrent protective devices and controllers not already factory installed. Set field-adjustable, circuit-breaker trip ranges.

I. Install filler plates in unused spaces.

J. Stub four (4) 1-inch and two (2) 1-1/4-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future. Provide suitable closures for spare conduits and identify with a suitable label.

K. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

L. Comply with NECA 1.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, use a calibrated torque tool to achieve that indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553, "Identification for Electrical Systems" and as noted below:

1. Provide a directory card inside each door, covered with a plastic non-yellowing shield. Directory Card to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer to create directory in Microsoft Excel; handwritten directories are not acceptable. Digital versions to be provided to Owner.
2. The room numbers used to fill out the panel directories shall match the actual final name and numbering scheme selected by the Owner. They shall not be filled out per the construction drawing numbering scheme, unless the Contractor is directed to do so by the Architect or Engineer.
3. Provide nameplate for each panelboard.
4. For distribution panelboards, provide nameplate for each branch circuit device.

5. All distribution equipment shall be shipped from the manufacturer with factory-applied warning labels affixed to the outside front of the equipment (as it will be installed per the plans). All labeling shall be in compliance with NFPA 70 requirements.
6. Labels affixed to equipment by the equipment manufacturer shall comply with drawing and specification labeling requirements or shall be omitted by the manufacturer and field-installed by the Contractor. Labels which are factory-installed and not in compliance shall be removed and replaced and equipment enclosures refinished or replaced by the manufacturer to repair finish.

3.5 FIELD QUALITY CONTROL

A. Perform the following Tests and Inspections:

1. Visual and Mechanical Inspection:

   a. Examine equipment nameplate data and confirm proper identification.
   b. Inspect the physical, electrical, and mechanical condition of the equipment and all components in accordance with the manufacturers' instructions.
   c. Inspect anchorage, alignment, and grounding.
   d. Inspect bolted electrical connections and terminations for high resistance by verifying tightness with calibrated torque-wrench method in accordance with manufacturer's published data.
   e. Exercise all active components.
   f. Inspect all mechanical indicating devices for correct operation.
   g. Physically test key interlock systems to check for proper functionality prior to energizing.

2. Electrical Acceptance Testing:

   a. Perform insulation resistance test for one minute on each panelboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the panelboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test. Test voltages and minimum resistance shall be in accordance with manufacturer's published data.

3. Circuit Breaker Testing: For all circuit breakers with electronic trip units, determine minimum pickup current, long-time and short-time pickup and delay, and instantaneous pickup by secondary current injection. Certify compliance with test parameters and ensure settings match recommendations from final approved power system study.
4. Test ground-fault protection of equipment for service equipment per NFPA 70.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.7 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573, “Power System Studies”.

C. All circuit breakers identified as spares shall be left in the OFF position.

END OF SECTION

SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. This section of the specifications covers all wiring devices and cover plates, standard, weatherproof and dust-tight.

B. Section Includes:

1. Straight Blade receptacles.
2. GFCI receptacles.
3. USB receptacles.
4. General use snap switches.
5. Manual Motor Control switches.
6. Wall Plates.
7. Floor service fittings.

1.3 REFERENCES

A. Abbreviations

1. AFCI: Arc-fault circuit interrupter.
2. CR: Corrosion Resistant
3. EMI: Electromagnetic interference.
4. GFCI: Ground-fault circuit interrupter.
5. IG: Isolated Ground
6. SPD: Surge Protective Device
7. TR: Tamper Resistant.
8. USB: Universal Serial Bus.
9. WR: Weather Resistant.

B. Definitions

1. Emergency Electrical Systems: Those systems legally required and classed as emergency by NFPA 70 Article 700, municipal, state, other codes, or by any government agency having jurisdiction.
2. Essential Electrical Systems: Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system as defined by NFPA 70 Article 517 and NFPA 99.

3. Outlet: A point on the wiring system at which current is taken to supply utilization equipment.
4. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
5. Receptacle. A receptacle is a contact device installed at the outlet for the connection of an attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. National Electrical Contractors Association (NECA):
   a. NECA 130, "Standard for Installing and Maintaining Wiring Devices"
2. National Electrical Manufacturers Association (NEMA)
   a. NEMA WD 1, "General Color Requirements for Wiring Devices"
   b. NEMA WD 6, "Wiring Devices—Dimensional Specifications"

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Schedules: List of legends and description of materials and process used for pre-marking wall plates.

C. Samples: Where requested by architect or engineer, one for each type of device and wall plate, in each color specified.

D. Closeout Submittals
1. Operation and Maintenance Data: For Wiring Devices to include in operation and maintenance manuals.
2. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
   a. Manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated or equal from one of the following:

1. Eaton/Arrow Hart
2. Hubbell
3. Leviton
4. Pass & Seymour/Legrand

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Devices for Fixtures, Furnishings, and Equipment:
   1. Receptacles: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

E. All terminations shall be side-wired clamping type. “Backstab” terminations or modular connectors are not permitted.

F. Device Color:
   1. Wiring devices in finished spaces connected to normal power system: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
   2. Wiring Devices in unfinished spaces connected to normal power system: Grey unless otherwise indicated or required by NFPA 70 or device listing.
   3. Wiring Devices Connected to Emergency or Essential Electrical System: Red.

G. Wall Plate Color:
   1. For plastic covers, match device color unless noted otherwise.
   2. Where normal and essential system devices are ganged under a common wall plate, the plate shall be the color of normal power plates.

2.3 SPECIFICATION GRADE STRAIGHT-BLADE RECEPTACLES

A. Specification Grade Receptacle, Comply with NEMA WD 6, UL 498, FS W-C-596.

TYPE	RATING	CONFIGURATION	BASIS OF DESIGN
Duplex	20A, 125V	NEMA 5-20R	Hubbell 5362
Single	20A, 125V	NEMA 5-20R	Hubbell 5361
Duplex-TR	20A, 125V	NEMA 5-20R	Hubbell 5362TR
Duplex-IG	20A, 125V	NEMA 5-20R	Hubbell IG5362
Duplex-WR	20A, 125V	NEMA 5-20R	Hubbell 5362WR
Duplex-CR	20A, 125V	NEMA 5-20R	Hubbell HBL53CM62
Single	30A, 250V	NEMA 6-30R	Hubbell HBL9330
Single	50A, 250V	NEMA 6-50R	Hubbell HBL9367

Single	20A, 250V	NEMA 10-20R	Hubbell HBL9326

2.4 SPECIFICATION GRADE GFCI RECEPTACLES

A. Specification Grade GFCI Receptacles, Comply with UL 498, FS W-C-596, and UL 943 Class A.

B. Non-feed through type unless otherwise required, Integral self-testing GFCI with "Test" and "Reset" buttons and LED indicator light that is lighted when the unit is tripped. If critical components are damaged and ground fault protection is lost, power to receptacle shall be discontinued.

TYPE	RATING	CONFIGURATION	BASIS OF DESIGN
Duplex GFCI	20A, 125V	NEMA 5-20R	Hubbell GFRST20
Duplex GFCI with Alarm	20A, 125V	NEMA 5-20R	Hubbell GFRST20A
Duplex GFCI - TR	20A, 125V	NEMA 5-20R	Hubbell GFTRST20
Duplex GFCI - WR	20A, 125V	NEMA 5-20R	Hubbell GFTWRST20
Duplex GFCI - CR	20A, 125V	NEMA 5-20R	Hubbell GFRST52M
GFCI Blank Face	20A, 125V		Hubbell GFBFST20

2.5

2.5 USB RECEPTACLES

A. USB Charging Receptacle and Outlet, Comply with UL 1310 and USB 3.0 devices.

B. Dual port, combination USB Type A and C, 5 V dc, and 5 A per receptacle (minimum).

TYPE	RATING	CONFIGURATION	BASIS OF DESIGN
Duplex USB - TR	20A, 125V	NEMA 5-20R	Hubbell USB20AC5
Duplex USB - WR	20A, 125V	NEMA 5-20R	Hubbell USB20AC5WR

2.6 GENERAL USE SNAP SWITCHES

A. Switches, 120/277 V, Comply with UL 20 and FS W-S-896.

TYPE	RATING	CONFIGURATION	BASIS OF DESIGN
Single Pole	20A, 120/277V		Hubbell 1221
Double Pole	20A, 120/277V		Hubbell 1222
Three Way	20A, 120/277V		Hubbell 1223
Four Way	20A, 120/277V		Hubbell 1224

B. Pilot-Light Switches, illuminated when switch is ON:

TYPE	RATING	CONFIGURATION	BASIS OF DESIGN
Single Pole	20A, 120/277V		Hubbell 1221PL

C. Illuminated Switches, illuminated when switch is OFF:

TYPE	RATING	CONFIGURATION	BASIS OF DESIGN
Single Pole	20A, 120/277V		Hubbell 1221IL

D. Key-Operated Switches, Factory-supplied key in lieu of switch handle:

TYPE	RATING	CONFIGURATION	BASIS OF DESIGN
Single Pole	20A, 120/277V		Hubbell 1221L
Three Way	20A, 120/277V		Hubbell 1223L
Four Way	20A, 120/277V		Hubbell 1224L

E. Double-Throw, Momentary-Contact, Center-off Switches.

TYPE	RATING	CONFIGURATION	BASIS OF DESIGN
Single Pole	20A, 120/277V		Hubbell 1557
Low Voltage	5A, 24VDC		Hubbell 1557LV

2.7 MANUAL MOTOR CONTROL SWITCHES

A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle type for manual control of single or three phase motors up to 3/4 HP where overload protection is not required or is provided separately, marked to indicate whether unit is on or off.
   1. Standard: Comply with NEMA ICS 2, general purpose, Class A.

B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle type with integral overload protection for use with single phase motors up to 1HP; marked to show whether unit is off, on, or tripped.
   1. Configuration: Non-reversing unless noted otherwise on drawings.
   2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor and ambient temperature; external reset push button; melting alloy type.
   3. Red pilot light where indicated on drawings.
   4. HOA selector switch with dry contact inputs where indicated on drawings.

C. Provide with NEMA 1, NEMA 3R or other enclosure suitable for the location and atmosphere.

D. All manual starters located in finished areas shall be in flush-mounted enclosures.

2.8 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Smooth, 0.060-inch high-impact thermoplastic.
   3. Material for Unfinished Spaces: type 304 stainless steel.
   4. Material for Rough Service Locations including gymnasiums, kitchens, mechanical rooms, material management, and food service areas: satin-finished, Type 304 stainless steel.
      a. For kitchen and food service areas, provide foam gasket behind plate to help prevent water infiltration.

B. Material for Interior Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-location, Weatherproof, in-use cover plates: extra duty, suitable for use with and decorator style devices, die-cast aluminum lockable cover, self-closing, gasketed, standard box mounting.
   1. Vertical mounting - Hubbell WP26E or equal.
   2. Horizontal mounting - Hubbell WP26EH or equal.

D. Cover plates for lighting control devices exposed to severe physical damage: Low profile, flip-up clear polycarbonate cover. STI Stopper or equal.

PART 3 - EXECUTION

3.1 APPLICATION

A. Provide receptacles and cover plates listed for the installed environment.

B. Outdoor receptacles and receptacles located in wet locations shall be weather resistant, GFCI type, with weather proof enclosure.

C. Provide GFCI receptacles where required by the NEC in addition to the locations noted on the drawings.

D. Provide weather-resistant rating for GFCI receptacles installed in wet locations.

E. Where GFCI receptacles are located in areas that are not readily accessible, provide GFCI blank face device in readily accessible location approved by Architect.

F. Provide GFCI receptacles with audible alarm for refrigeration and vending applications.

G. Provide tamper resistant receptacles where required by the NEC in addition to the locations noted on the drawings.

3.2 INSTALLATION

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA 130.

B. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.

C. Devices that have been installed before painting shall be masked. No plates or covers shall be installed until all finishing and cleaning has been completed. Replace stained or improperly painted wiring devices and coverplates.

D. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required. Where GFCI receptacles share a single circuit with other devices, a ground fault on any GFCI receptacle shall not interrupt power to downstream devices.

E. Coordination for all receptacles: Confirm receptacle configuration of all special purpose receptacles with approved submittals prior to installation and provide devices to match equipment plugs. Contractor shall replace any incompatible receptacle discovered during owner move-in.

F. Coordination with Other Trades:

1. Adjust locations of outlets to suit arrangement of partitions and furnishings. Locate outlets to avoid blocking by supports, furnishings, and other architectural fixtures.
2. Adjust locations of floor boxes and poke-throughs to coordinate with locations of structural members, concealed piping, and concealed conduit.
3. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
4. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
5. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
6. Install wiring devices after all wall preparation, including painting, is complete.

G. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Where re-using existing conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

H. Device Installation:

1. Replace all devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until all finish work is complete.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. Use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than #12 AWG are installed on 15- or 20-A circuits, splice #12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
10. Install devices and assemblies level, plumb, and square with building lines. Align devices vertically and horizontally. Securely fasten devices into boxes.

I. Device Orientation:

1. Install switches with “OFF” position down.
2. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left so the neutral blade is at the top.

J. Device Plates:

1. Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
2. All outlets not provided with wiring devices shall be closed with a blank plate matching other plates in the area.
3. Align coverplate mounting screw slots in the same direction, either vertical or horizontal. Do not overtighten coverplate mounting screws. Overtightening can cause the coverplate to warp, dimple, bend, and in the case of plastic faceplates, crack or break.

3.3 IDENTIFICATION:

A. Comply with Section 260553 "Identification for Electrical Systems."

1. All device wall plates shall be labeled with panel and circuit designation by means of machine printed adhesive tape. Select face plates shall be engraved. Refer to drawings.
2. All device boxes shall have circuit number identified within the box.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Using a test plug, perform the following tests and inspections for receptacles:

1. Insert and remove test plug to verify that devices are securely mounted.
2. Verify correct configuration of hot, neutral, and ground pins.
3. Verify correct operation of ground fault protective devices.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 262813

FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Description: Provide labor, material, equipment, related services, and supervision required for the installation of cartridge fuses where utilized for overcurrent and/or current limitation applications.

B. Section Includes:

1. Cartridge fuses rated 600V-AC and less for use in control circuits, enclosed switches, panelboards, switchboards, and motor controllers.
2. Spare fuse cabinet.

1.3 REFERENCES

A. Definitions

1. Fuse: A protective device that opens a circuit during specified overcurrent conditions by means of a current responsive element.

B. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. National Electrical Contractors Association (NECA)
   a. NECA 420, "Fuse Applications"

1.4 SEQUENCING

A. Submit the preliminary power system study prior to receiving final approval of equipment and system protective devices submittals and prior to release of equipment drawings for manufacturing. Adjust equipment sizes, frame sizes, and trip units as necessary to achieve performance requirements outlined in Section 260573, "Power Systems Studies".

1.5 SUBMITTALS

A. Product Data: For each fuse type indicated:

1. Include let-through current curves for fuses with current-limiting characteristics.
2. Time-current curves, coordination charts and tables, and related data.

B. Ambient Temperature Adjustment Information: Where ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

C. Closeout Submittals

1. Operation and Maintenance Data: For Fuses include in emergency, operation, and maintenance manuals.
2. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
   a. Let-through current curves for fuses with current-limiting characteristics.
   b. Time-current curves, coordination charts and tables, and related data.
   c. Ambient temperature adjustment information.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels indicated in power system study.

1.7 MAINTENANCE 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. Fuses: Equal to one spare for every 10 installed units, but not less than 5 units for each size and type.
2. Fuse Pullers: Two for each size and type.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace fuses that fail in materials or workmanship within 12 months from date of Substantial Completion.

1.9 FIELD CONDITIONS

A. Where ambient temperature to which fuses are exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bussmann, Inc.
2. Littlefuse, Inc.
3. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with:

1. NEMA FU 1 – Low Voltage Cartridge Fuses.
2. UL 248 – Standard for Low Voltage Fuses.
3. UL 512 – Fuseholders.

2.3 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 250 or 600-V, zero- to 600-A rating, 200 kAIC minimum, fast acting or time delay.
2. Type RK-5: 250 or 600-V, zero- to 600-A rating, 200 kAIC minimum, fast acting or time delay.
3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC minimum, fast acting or time delay.
4. Type L: 600-V, 601- to 6000-A rating, 200 kAIC minimum, time delay option.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

C. Provide dual element fuses with separate overload and short circuit elements.

2.4 SPARE-FUSE CABINET

A. Manufacturer: Bussmann #SFC-FUSE-CAB spare fuse cabinet or equal.

B. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.

3. Identification: "SPARE FUSES" in 1-1/2 inch high white letters on black lamicoid plate. Mount plate on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPICATIONS

A. Service, Feeders, and Branch Circuits (601-6000A): Class L, time delay. Bussmann HI-CAP Fuses KRP-C or equal. Fuses shall hold 500% of rated current for a minimum of 4 seconds.

B. Feeders and Branch Circuits (0-600A): Class RK1, time delay. Bussmann Low-Peak Dual Element Fuses, LPN-RK (250 volts) or LPS-RK (600 volts) or equal. The fuse shall hold 500% of rated current for a minimum of 10 seconds.

C. Motor Circuits – Class RK1 or Class L, time delay as indicated above.

1. Motor with 1.15 service factor: Size at 125% of motor FLA. For high inrush current applications size 150% to 200% of motor FLA.
2. Motor with 1.0 service factor: Size at 115% of motor FLA.

D. Control Circuits: Class CC, time delay. Bussmann Low-Peak Fuses LP-CC or equal. Fuses shall hold 200% of rated current for a minimum of 12 seconds.

E. Adjust fuse type and selection as required to ensure available fault current at equipment controllers indicated in power systems study does not exceed labeled SCCR values.

3.3 INSTALLATION

A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energizing at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energizing of the circuit in which it is applied.

B. No fuses shall be installed in the equipment until the installation is complete, including tests and inspections required prior to being energized. All fuses shall be of the same manufacturer to ensure retention of selective coordination, as designed.

C. Provide a complete set of fuses for all fusible devices. Arrange fuses so rating information is readable without removing fuse.

D. Install spare-fuse cabinet(s). Locate in Main Electrical Room.

E. Upon completion of the building, the Contractor shall provide the Owner with spare fuses in Spare-Fuse Cabinet.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems".

1. Indicate fuse rating and type on the outside door of each fused switch.

END OF SECTION

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Description: Section includes requirements for the provision of individually enclosed switches and circuit breakers including manufacturing, fabrication, configuration and installation as required for the complete performance of the Work, as shown on the drawings and specifications

B. Section includes:

1. Fusible and Non-Fusible Switches.
2. Enclosed Circuit Breakers.
3. Enclosures.

1.3 REFERENCES

A. Abbreviations

1. HD: Heavy Duty
2. MCCB: Molded Case Circuit Breaker
3. NC: Normally Closed
4. NO: Normally Open
5. SCCR: Short Circuit Current Rating

B. Definitions

1. Disconnect: A switch, device, group of devices, or other means used to disconnect conductors of a circuit from their source of supply.
2. Switch (switching device): A device, manually operated, unless otherwise designated, for opening and closing or for changing the connection of a circuit. Also referred to as safety switches or disconnect switches.

1.4 SEQUENCING

A. Submit the preliminary power system study prior to receiving final approval of equipment and system protective devices submittals and prior to release of equipment drawings for

manufacturing. Adjust equipment sizes, frame sizes, and trip units as necessary to achieve performance requirements outlined in Section 260573, "Power Systems Studies".

1.5 SUBMITTALS

A. Product Data: For each product type.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Short-circuit current ratings (interrupting and withstand, as appropriate).
3. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Cable terminal size and quantity.

C. Closeout Submittals

1. Operation and Maintenance Data: For enclosed switches and circuit breakers include in emergency, operation, and maintenance manuals.
2. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
   a. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 COORDINATION

A. Product Selection for Restricted Space: Drawings indicate space available for enclosed switches including clearances between enclosed switches and adjacent surfaces and other items. Furnish and install equipment to comply with NEC clearances.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace devices that fail in materials or workmanship within 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB/General Electric.
2. Eaton Electrical Inc.
3. Siemens.
4. Square D

B. Source Limitations: Obtain enclosed switches, overcurrent protection devices, and all other electrical distribution equipment through one source from a single manufacturer unless approved otherwise.

2.2 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Service-Rated Switches and Circuit Breakers: Labeled for use as service equipment.

D. Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Switch and overcurrent protective device short circuit ratings shall be at least 110% of the actual available fault current.

2.3 FUSIBLE AND NON-FUSIBLE SWITCHES

A. Type HD, Heavy Duty, Single Throw, 250-VAC or 600-VAC, 1200 A and Smaller unless noted otherwise.

B. Quick-make, quick-break operating handle and switch mechanism integral to box.

C. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses where indicated.

D. Externally operable dual interlocked handle to prevent opening front cover with switch in ON position, or closing switch when door is open. Visible load interrupter knife switch blades in the off position with door open.

E. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.

G. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: UL Listed, mechanical type, front removeable, and suitable for number, size, and conductor material at 75 deg C.
4. Auxiliary Contact Kit: NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating as required for application.
5. Electrical Interlock Kit: Pivot arm operated from the switch mechanism, breaking a control circuit before the main switch blades break.

H. For receptacle switches provide interlocking linkage between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

2.4 ENCLOSED MOLDED-CASE CIRCUIT BREAKERS

A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. MCCBs shall be equipped with a device for locking in the open position.

E. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

F. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Long-time, Short-time, and Instantaneous trip unless noted otherwise on drawings.

G. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single-, two-pole, and three-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: UL Listed, mechanical type, suitable for number, size, trip ratings, and conductor material at 75 deg C.
   3. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact. Coordinate coil voltage and provide control circuits as required for application.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor and Wet Locations: NEMA 250, Type 3R.
   3. Kitchen and Wash-Down Areas: NEMA 250, Type 3R, stainless steel.

B. Enclosure Finish: The enclosure shall be finished with the standard manufacturer gray finish.

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Securely fasten each switch and circuit breaker to the supporting structure or wall, utilizing a minimum of four (4) 1/4-inch bolts. Do not mount in an inaccessible location or where the passageway to the switch may become obstructed.

D. After equipment has been installed, inspected, and is ready to be energized, install fuses in fusible devices in accordance with equipment nameplates and Section 262816, “Fuses”.

E. Comply with NFPA 70 and NECA 1.

F. Provide electrical interlock kit and low voltage wiring where utilized on the line side of VFD controller to shut down VFD prior to disconnection of power. Coordinate control wire termination with Division 25.

G. Provide electronic trip breakers where required to achieve performance requirements outlined in Section 260573, "Power Systems Studies".

H. Provide fusible switches with current limiting fuses or current limiting circuit breaker for equipment disconnecting means where equipment short circuit current rating is insufficient for available fault current.

I. Where battery lowering devices are specified with Hydraulic Elevators, provide connection between an auxiliary contact at the elevator disconnect and the battery lowering device.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, use a calibrated torque tool to achieve that indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553, "Identification for Electrical Systems"

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with nameplate.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Visual and Mechanical Inspection:
    a. Examine equipment nameplate data and confirm proper identification.
    b. Verify and record fuses sizes and types are in accordance with nameplates and power systems study.
    c. Inspect the physical, electrical, and mechanical condition of the equipment and all components in accordance with the manufacturers' instructions.
    d. Inspect anchorage, alignment, and grounding.
    e. Inspect bolted electrical connections and terminations for high resistance by verifying tightness with calibrated torque-wrench method in accordance with manufacturer's published data.
    f. Exercise all active components to ensure proper mechanical operation.
    g. Check all interlocking systems for correct operation.
2. Test ground-fault protection of equipment for service equipment per NFPA 70.

3. Test all auxiliary devices/system interfaces and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Switches and Circuit Breakers will be considered defective if they do not pass tests and inspections.

C. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Prepare test and inspection reports, including a certified report that identifies switches and circuit breakers included and that describes results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Power System Studies".

END OF SECTION

SECTION 262900

MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY:

A. Extent of motor starter work is indicated by drawings and schedules.

B. Section includes:

1. Combination full voltage, non-reversing Motor Controllers.
2. Combination Soft Start Motor Controllers

C. Related Requirements:

1. Refer to Section 260500 "Common Work Results for Electrical Systems" for additional requirements related to motors connections.
2. Refer to Section 262726 "Wiring Devices" for information on manual motor controllers.
3. Refer to Division 25 for coordinating requirements related to control system interface points.

1.3 REFERENCES

A. Abbreviations

1. FVNR: Full Voltage Non Reversing
2. MCP: Motor Circuit Protector
3. OCPD: Overcurrent protective device
4. SCCR: Short Circuit Current Rating
5. SCPD: Short-circuit protective device
6. SCR: Silicon Controlled Rectifier

B. Definitions

1. Soft Starter: Solid state reduced voltage non-reversing motor controller

1.4 SEQUENCING

A. Submit the preliminary power system study prior to receiving final approval of equipment and system protective devices submittals and prior to release of equipment drawings for manufacturing. Adjust equipment sizes, frame sizes, and trip units as necessary to achieve performance requirements outlined in Section 260573, "Power Systems Studies".

1.5 SUBMITTALS:

A. Product Data: For each type of product.

B. Shop Drawings: For each type of product.

1. Include wiring diagrams for signal and control wiring. Clearly identify manufacturer-installed and field installed wiring.
2. Include features and factory settings of individual protective devices and auxiliary components.

C. Closeout Submittal:

1. Operation and Maintenance Data: For motor controllers to include in operation and maintenance manuals.
2. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
   a. Routine maintenance requirements for magnetic controllers and installed components.
   b. Manufacturer's written instructions for testing and adjusting circuit breaker and motor circuit protector trip settings.
   c. Manufacturer's written instructions for setting field-adjustable overload relays.
   d. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 MAINTENANCE MATERIAL

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

1. Fuses: Equal to one spare for every 10 installed units, but not less than 5 units for each size and type.
2. Overloads: Equal to one spare for every 9 installed units, but not less than 3 units for each size and type.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace enclosures, starters, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

B. UL Compliance and Labeling: Fabricate and label motor controllers to comply with UL 508.

C. NEC Compliance: Comply with NEC as applicable to wiring methods, construction and installation of motor starters.

D. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to motor controllers/starters and enclosures.

2.2 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products from one of the following:

1. ABB/General Electric
2. Allen Bradley Co.
3. Eaton
4. Siemens.
5. Square D. Co.

2.3 MANUAL MOTOR CONTROLLERS

A. Refer to Section 262726 "Wiring Devices" for manual motor controller requirements.

2.4 COMBINATION FULL VOLTAGE MOTOR CONTROLLER

A. Description: Factory-assembled, combination full-voltage, non-reversing magnetic motor controller consisting of the controller, indicated disconnecting means, SCPD, OCPD, pushbuttons, selector switch(es), and indicator lights in a single enclosure.

B. All combination starter/disconnect switches shall have low-voltage protection, solid state overloads, start / stop pushbuttons, Hand-Off-Auto selector switch and Red and Green pilot lights.

C. All combination starter/disconnect switches shall be Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Combination motor starters shall be rated in accordance with NEMA sizes and horsepower ratings. No starter shall be listed as a fractional size. Contactor contacts shall be silver alloy, double break, and shall allow for inspection on NEMA Sizes 00 through 4 without the use of tools. Size 5 and larger shall allow for inspection utilizing standard tools. They shall be replaceable without removing the line, load, or control wiring from the starter, and replaceable without removing the starter from the enclosure.

E. Contactor coils shall be the encapsulated type, and shall be replaceable on NEMA Sizes 00 through 4 without the use of tools. Size 5 and larger shall be replaceable with standard tools. They shall be replaceable without removing the line, load, or control wiring from the starter, and replaceable without removing the starter from the enclosure.

F. Overload protection shall be provided by solid state electronic overload relay. Single-phase starters shall provide one- or two-leg overload protection; three-phase starters shall provide three-leg overload protection. Overload protection shall be class 10/20 selectable, have visible trip indicator, and manual or remote reset function.

G. Starter shall include phase failure relay with under-voltage protection.

H. Starter shall have integral controls transformer with primary and secondary fusing.

I. Starter to have two normally closed and two normally open auxiliary contacts.

J. Combination starter shall be suitable for straight through wiring.

K. Fusible Disconnecting Means: Heavy Duty, quick-make, quick-break, load break rated, such that during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing and opening action of the contacts has started. The handle and mechanism shall be an integral part of the box (not cover) with facilities for pad locking in the open or closed position with up to three padlocks. Switch doors shall be interlocked with switch handle so that the door can only be opened when the switch is in the "OFF" (open) position.

L. All safety switches shall have a factory installed neutral lug, when a neutral is necessary.

M. All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.

N. Provide the following Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.5 COMBINATION SOFT START MOTOR CONTROLLER

A. Description: Factory Assembled, Solid state, reduced voltage, non-reversing motor controller consisting of controller, disconnecting means, protection devices, microprocessor with digital keypad in a single enclosure.

B. Enclosure shall include a door mounted digital keypad for adjusting the soft starter parameters and viewing process values and viewing the motor and soft starter status without opening the enclosure door. Provisions shall be available for padlocking the enclosure door.

C. The enclosed product shall be provided with molded case disconnect switch and in-line fuse block for Class J power fuses from 10 to 600A or Class L power fuses from 601 to 1600A for Type 1 short circuit protection.

D. The motor must be automatically protected from solid state component failure by an isolation contactor that opens when the motor is stopped or when the controller detects a fault condition including a shorted SCR.

E. The soft starter shall utilize an SCR bridge consisting of at least two SCRs per phase to control the starting and stopping of industry standard motors.

F. The soft start shall provide torque control for linear acceleration independent of motor load or application type without external feedback. The gating of the SCRs will be controlled in such a manner to ensure stable and linear acceleration ramp.

G. The soft starter shall be controlled by a microprocessor that continuously monitors the current and controls the phasing of the SCRs. Analog control algorithms shall not be allowed.

H. A shorting contactor shall be standard on soft starters in all enclosure configurations. Protective features and deceleration control options integral to the soft starter shall be available even when the shorting contactor is engaged.

I. The SCRs shall have a minimum P.I.V. rating of 1800 Vac. Lower rated SCRs with MOV protection are not acceptable.

J. All programming/configuration devices, display units, and field control wiring terminals shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments is prohibited.

K. Digital indication shall provide, as a minimum, the following conditions:

1. Soft starter status - ready, starting/stopping, run.
2. Motor status - current, torque, thermal state, power factor, operating time, power in kW.
3. Fault status - Motor thermal overload, soft starter thermal fault, loss of line or motor phase, line frequency fault, low line voltage fault, locked rotor fault, motor underload, maximum start time exceeded, external fault, serial communication fault, line phase reversal fault, motor overcurrent fault.

L. The soft starter must be preset to the following for adjustment-free operation in most applications:

1. Linear (torque-controlled) acceleration ramp of 15 seconds.
2. Current limitation to 400% of the motor full load current rating.
3. Class 10 overload protection.
4. Motor current preset per NEC / NFPA 70 table 430.150 for standard hp motors.

M. A digital keypad shall be utilized to configure operating and controller parameters such as FLA, acceleration ramp, torque, braking type, thermal overload Class, reset functions, etc.

N. Provide output relays to provide the following status indications:

1. One Form A (N.O.) minimum for indication of fault.
2. One Form A (N.O.) for indication that acceleration ramp is complete and current is below 130% motor FLA (end of start).
3. One Form A (N.O.) assignable to one of the following functions: motor thermal alarm, motor current level alarm, and motor underload alarm.

O. A microprocessor-based thermal protection system shall be included which continuously calculates the temperature-rise of the motor and soft starter and provides:

1. A motor overload pre-alarm that indicates by relay contact or logic output that the motor windings have exceeded 130% of its rated temperature rise. This function shall be for alarm only.
2. A motor overload fault will stop the motor if the windings have exceeded 140% of temperature-rise.
3. An electronic circuit with a time-constant adjustable to the motor's thermal cooling time-constant ensuring the memorization of the thermal state even if power is removed from the soft starter.
4. The soft starter shall provide line and motor phase loss, phase reversal, underload, stall, and jam protection.
5. The integral protective features shall be active even when the shorting contactor is used to bypass the SCRs during steady state operation.

6. The soft starter control circuit shall be fed from the line supply and be completely independent of the power circuit and separate from the control logic.

P. The peripheral soft starter control circuitry shall be operated at 120 Vac 60 Hz from a control power transformer included within the enclosure.

Q. Operator devices shall be door mounted and shall be:

1. Red STOP and black START push buttons.
2. Three position H-O-A switch which provides for manual (HAND) start or remote signal (AUTO) start from user-supplied relay contacts.
3. Three position FWD-OFF-REV switch provides forward, off and reverse selector switch mounted on the door (available with reversing starter only).
4. Red RUN pilot light illuminated whenever the soft starter is provided a run command and no fault condition is present.
5. Green OFF pilot light illuminated whenever the soft starter is supplied with control power and no run command is present.
6. All operator devices shall be remote-mounted using supplied 120 Vac control logic. Clearly labeled terminals shall be provided for field installation.

R. Provide a shorting contactor that shall close, shorting the SCRs after the acceleration ramp is compete and motor current is below 130% of motor FLA, and open on a stop command to allow a deceleration ramp. Overload protection integral to the soft starter shall continue to protect the motor when shorting is engaged. A microprocessor shall control the operation of the shorting contactor via an output relay.

S. Provide full voltage bypass starter with overload protection to provide motor operation in the event of soft starter failure. Provide "NORM/BYPASS" selector switch on enclosure door.

PART 3 - EXECUTION

3.1 MOTOR CONTROLLER APPLICATION

A. FVNR and Soft Starter type motor controllers shall be combination type starter and disconnect switch unless noted otherwise on plans.

B. Starters smaller than 10HP shall be full voltage non-reversing type (FVNR). Starters 10HP and larger shall be soft starters.

C. SCCR ratings shall exceed the available fault current calculated by the power system study as required by Section 260573, "Power System Studies".

D. The starter shall be designed to operate in the environment in which installed including ambient temperature, humidity, and elevation.

E. Enclosure:

1. Type of each starter to comply with environmental conditions at installed location:
   a. Indoor, Dry and Clean Locations: NEMA 250, Type 1
   b. Outdoor Locations: NEMA 250, Type 3R.
   c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
2. Provide provisions for padlocking the enclosure door.

3.2 EXAMINATION

A. Examine elements and surfaces to receive motor starters for compliance with installation tolerances, relationship to motors, and other conditions affecting performance of the Work.

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

3.3 INSTALLATION OF MOTOR CONTROLLERS:

A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA standards, and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Securely fasten each switch, circuit breaker and combination starter to the supporting structure or wall, utilizing a minimum of four (4) 1/4 inch bolts.

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NEC. Do not mount in an inaccessible location or where the passageway to the switch may become obstructed.

E. Install fuses in fusible devices in accordance with Section 262813, "Fuses".

F. Select and set overloads on the basis of full-load current rating as shown on motor nameplate.

G. Verify that overcurrent and overload protection devices are properly matched to actual motor nameplate data and service class.

H. Provide conductor reducers, taps and splices, as required, for proper termination of all branch circuits and feeders at disconnect switches, panelboards, motor starters, VFDs, etc. This shall include where conductors have been oversized to accommodate voltage drop, motor circuit conductor protection, and all instances where conductors are unable to terminate at factory lugs.

I. Final 18 inch of power wiring to motor shall be in liquid tight flexible conduit.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, use a calibrated torque tool to achieve that indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

3.5 IDENTIFICATION

A. Comply with requirements in Section 260553, "Identification for Electrical Systems"

1. Identify field-installed conductors, interconnecting wiring, and components.

2. Provide Warning Signs.
3. Label each enclosure with nameplate.

3.6 FIELD QUALITY CONTROL:

A. Perform Test and Inspections:

1. Visual and Mechanical Inspection:
    a. Compare equipment nameplate data with drawings and specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
    e. Inspect contactors:
        1) Verify mechanical operation.
        2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
    f. Motor Protection:
        1) Verify overload element rating is correct for its application.
        2) If motor-running protection is provided by fuses, verify correct fuse rating.
    g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench or low resistance ohmmeter. Bolt-torque levels and/or bolted connection resistance values shall be according to manufacturer's published data.
    h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
2. Electrical Tests:
    a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data.
    b. Test motor protection devices according to manufacturer's published data.
    c. Verify voltages at the controller locations are within plus or minus 10 percent of the motor nameplate rated voltages. If outside the range for any motor, notify the design team before starting the motor.
    d. Perform operational tests by initiating control devices.
    e. Test all auxiliary devices/system interfaces and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Motor controller will be considered defective if it does not pass tests and inspections.

C. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance, otherwise replace with new units and retest.

D. Prepare test and inspection reports, including a certified report that identifies motor controllers included and that describes results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION.

SECTION 264100

FACILITY LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Section includes requirements for providing a complete UL master labeled traditional lightning protection system for ordinary structures.

B. Related Requirements:

1. Refer to Section 260526, "Grounding and Bonding for Electrical Systems" for additional requirements related to grounding electrodes and connections.
2. Refer to Section 264300, "Surge Protection Devices" for additional requirements related to surge suppression.

1.3 REFERENCES

A. Abbreviations

1. LPI: Lightning Protection Institute
2. LPS: Lightning Protection System

B. Definitions

1. Grounding: Establishing a direct or indirect connection to Earth or some conducting body that serves in place of Earth.
2. Bonding: Method by which all non-energized conductive materials are effectively interconnected to create a low impedance path.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. National Fire Protection Association (NFPA)
   a. NFPA 780, Standard for the Installation of Lightning Protection Systems
2. Underwriters' Laboratories (UL)
   a. UL 96, Standard for Lightning Protection Components

1.4 COORDINATION

A. Where the new lightning protection system connects to an existing lightning protection system with or without a UL master label, the new portion of the lightning protection system requires UL inspection and a Letter of Findings.

B. Coordinate system scope and layout requirements, attachment methods, and envelope penetrations with architectural roof plans, elevations, and sections.

1.5 PREINSTALLATION MEETINGS

A. Schedule preconstruction conference with Architect, Owner, and all affected trades. Agenda topics should include, but are not limited to, the following:

1. System Installation Schedule.
2. Planned down conductor routing.
3. Planned building enclosure penetrations.
4. Building material compatibility.
5. Cutting and patching requirements.
6. Surge protection requirements.

1.6 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional responsible for their preparation.

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment and penetration details, coordinated with roof installation warranty.
5. Calculations required by NFPA 780 for bonding of metal bodies.

C. Delegated Design: For system layout, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional responsible for their preparation.

D. Qualification Data: For Installer.

E. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

F. Sample Warranty.

G. Closeout Submittals

1. Operation and Maintenance Data: For lightning protection system to include in maintenance manuals.

2. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems" include the following:

   a. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

3. As-Built Data: Dimensioned site plan showing dimensioned route of the grounding electrodes.

H. Completion Certificate:

1. UL Master Label Certificate suitable for fastening to building for display.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Regularly engaged in manufacturer of lightning protection equipment, of types, sizes and ratings required, whose products have been satisfactorily used in similar service for not less than 5 years. The firm shall be a member of and certified by the Lighting Protection Institute.

B. Installer Qualifications: A firm with at least 3 years of successful installation experience on projects with lightning protection work similar to that required for project

1. The System Design shall be completed and the shop drawing stamped by an LPI Certified Master Installer – Designer of Lightning Protection Systems.
2. The installing contractor shall be listed with the Lightning Protection Institute, and Underwriters' Laboratories, Inc.
3. The installation contractor shall have personnel on staff Certified by the LPI as a Master Installer – Designer of lightning protection systems.
4. LPI qualified staff, Journeyman or higher, shall provide on-site supervision of the installation.

1.8 WARRANTY

A. Furnish a 10-year adhesion warranty for all adhesives.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products from one of the following:

1. East Coast Lightning Protection
2. Harger
3. nVent Erico
4. Thompson Lightning Protection
5. VFC/Lyncole

B. Source Limitations: Obtain components through one source from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I materials on structures not exceeding 75ft and Class II materials on structures or portions of structures exceeding 75ft.

B. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency suitable to the Authority Having Jurisdiction as complying with UL 96, and marked for intended location and application.

C. Surge Suppression products for the electrical service entrance and communication services shall comply with NFPA 780 and UL 1449

2.3 MATERIALS

A. Comply with minimum Class I and Class II material requirements as listed in NFPA 780.

B. Air Terminals:

1. Aluminum unless otherwise required due to adjacent materials or existing conditions.
2. Safety tip.
3. Threaded base support: Adhesive type for membrane roof, non-penetrating clamp for standing seam metal roof.

C. Main and Secondary Conductors:

1. Aluminum unless otherwise required due to adjacent materials or existing conditions.
2. Smooth weave cable for Class I materials and Concentric or Ropelay for Class II materials
3. Cable Fastener: Adhesive type for membrane roof, non-penetrating clamp for standing seam metal roof.

D. Underground Conductors: Tinned copper.

E. Ground Rods:

1. Material: Copper-clad steel.
2. Diameter: 3/4 inch.
3. Rods: not less than 120 inches long.

F. Conductor Splices and Connectors for aboveground applications:

1. Suitable configuration and class type for the intended application and of the same material as the conductors or of electrolytically compatible materials

G. Adhesives: High performance, solvent free, UV resistant, for durable bond with substrate. All adhesives must be compatible with the roofing material and approved by the roofing system manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections without excessive splices. Maintain a horizontal or downward route along the entire path to ground. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.

C. Rigidly fasten exposed conductors at intervals not exceeding 3 feet.

D. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed systems in NFPA 780.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid bars and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Structural elements and design features shall be used whenever possible to minimize the visual impact of exposed conductors.
4. Coordinate sequence of installation with other trades to avoid coring, cutting, and patching.
5. Do not install conductors in gutters, downspouts, or on surfaces where water is retained.

E. Where conductors are exposed to potential damage or environmental hazards at grade level, provide guards to protect the conductors to a point 10 feet above grade. Bond down conductors to guards or conduit at both ends.

F. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

G. Provide Ground Ring Electrode for structures exceeding 60 feet. The conductor shall not be less than the main-size lightning conductor.

H. Where local conditions such as soil material, earth resistivity, or limited project boundary require the use of other grounding electrode configurations, refer to grounding electrode requirements in Section 260526, “Grounding and Bonding for Electrical Systems”.

I. Provide bonding between the LPS grounding electrode system and the Building grounding electrode system in accordance with NEC and NFPA 780 requirements.

J. Install surge suppression at all power service entrances and at all entrances of conductive communications systems.

K. Provide cutting and patch as necessary for installation of work in existing structures. Refer to Section 260500, “Common Work Results for Electrical Systems”.

3.2 CONNECTIONS

A. All connections to down conductors and connections in earth or concrete: Exothermic weld.

B. Aboveground concealed connections: Exothermic welds or high-compression fittings listed for the purpose.

C. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors, exothermic weld, high compression, or crimp type.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

E. Follow manufacturer's temperature and substrate requirements for installation of adhesives.

3.3 CORROSION PROTECTION

A. Coordinate lightning protection materials with building materials to assure compatibility.

B. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

C. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

D. Provide bimetallic connectors and fittings for splicing or bonding dissimilar metals.

E. Do not install aluminum materials in the following locations:

1. Embedded in or in direct contact with concrete, masonry, limestone, plaster, or mortar.
2. On copper surfaces or in locations exposed to direct water run-off from copper surfaces.
3. On a building surface coated with alkaline based paint.
4. In direct contact with earth or within 18-inches of the point where a conductor comes into contact with the earth.

F. Do not install copper materials in the following locations:

1. On aluminum surfaces or on exterior sheet metal surfaces.

3.4 FIELD QUALITY CONTROL

A. Testing: Upon completion of installation of lightning protection system, test resistance-to-ground with resistance tester. Where tests show resistance-to-ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms, or less, by driving additional ground rods.

B. Engage a third-party inspector to perform inspections required to obtain a UL Master Label for the system.

C. Prepare detailed test and inspection reports with corresponding test results and photos.

END OF SECTION

SECTION 264300

SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Description: The Contractor shall provide the necessary labor, materials, wiring and services necessary to provide the complete electrical surge protection systems as specified herein. This work shall include, but is not necessarily limited to provision of Surge Suppression Units at certain points in the power distribution network and proper installation in accordance with manufacturer's instructions.

B. Section includes:

1. Requirements for both field-mounted SPDs (externally mounted), and integrated SPDs (installed from the factory) for low voltage power distribution and control equipment.

1.3 REFERENCES

A. Abbreviations

1. MCOV: Maximum continuous operating voltage.
2. OCPD: Overcurrent protective device.
3. SCCR: Short-circuit current rating.
4. SPD: Surge protective device.
5. VPR: Voltage protection rating.

B. Definitions

1. Inominal: Nominal discharge current.
2. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
3. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
4. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.
5. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.
6. Type 3 SPDs: Point of utilization SPDs.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

   a. ANSI/IEEE C62.41.1, "Guide on the Surges Environment in Low Voltage (1000 V and Less) AC Power Circuits."
   b. ANSI/IEEE C62.41.2, "Recommended Practice on Characterization of Surges in Low Voltage (1000 V and Less) AC Power Circuits."
   c. ANSI/IEEE Standard C62.45, "Guide on Surge Testing for Equipment Connected to Low-Voltage Ac Power Circuits"

2. Underwriters Laboratories, Inc. (UL)

   a. UL 1283, "Standard for Safety for Electromagnetic Interference Filters."
   b. UL 1449, "Standard for Surge Protective Devices."

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Indicate all capacity ratings, clamp times, maximum capacities, physical characteristics and listing agency approvals.
2. Copy of UL certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.
3. Wiring diagram showing all manufacturer installed wiring including wire size, type, routing, and exact length of conductors.

B. Product Schedule: Indicate where each type of SPD is installed.

C. Closeout Submittal

1. Operation and Maintenance Data: For surge protection devices and components to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within a period of ten years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB/General Electric Company.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Siemens.
4. Square D; a brand of Schneider Electric.

B. Source Limitations: SPDs installed internal to the distribution system shall be of the same manufacturer as the equipment. The equipment shall be fully tested and certified in accordance with UL standards.

2.2 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

B. SPDs: Comply with UL 1449

1. Provide Type 1 SPDs installed on the line side of the service entrance OCPD and Type 2 SPDs installed on the load side of the service entrance OCPD.

C. Electrical Noise Filter: Comply with UL 1283 for Type 2 SPDs.

1. Each Type 2 unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz

D. Unit Operating Voltage: Refer to drawings.

E. MCOV of the SPD shall not be less than 115% of the nominal system voltage.

F. The suppression system shall incorporate thermally protected MOVs as the core surge suppression component for all distribution levels. Each MOV shall be individually fuse-protected to avoid cascading faults. The thermal protection assembly shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

G. SPDs shall be provided with the following features and accessories:

1. Integral disconnect switch for externally mounted SPDs. SPDs integrated into factory supplied equipment shall have an input disconnect switch or circuit breaker unless indicated on the equipment drawings/data sheets.
2. Internal fusing that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display (Red and Green) for power and protection status with push-to-test capabilities.
4. Audible alarm with silencing switch. Alarm shall activate when any one of the surge current modules has faulted or reached an end-of-life condition.
5. Form-C contacts, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device.
6. Surge counter with LCD display, reset switch, non-volatile memory, and battery backup to retain memory upon loss of AC power.

H. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

I. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than the following values. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

1. Category C, Service Entrance larger than 1200A: 400 kA/phase.

2. Category C, Service Entrance 1200A and below: 240 kA/phase.
3. Category B, Distribution larger than 1200A: 300 kA/phase.
4. Category B, Distribution 1200A and below: 160 kA/phase.
5. Category B, Branch: 120kA/phase.

J. Protection modes and UL 1449 VPR for grounded wye circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277V and 700 V for 208Y/120 V.
4. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.

K. SCCR: The short circuit current rating of the SPD shall be a minimum of 200kA and equal to or greater than the available short circuit current at the point on the system where installed.

L. Minimum Nominal Rating: 20 kA

2.3 SURGE SUPPRESSORS FOR OTHER SYSTEMS

A. Refer to specific specification sections for additional information on surge suppressors related to other building systems.

2.4 ENCLOSURES

A. Enclosure shall meet or exceed the ratings for the environment to be installed as indicated on drawings.
1. Indoor locations: NEMA 250, Type 1.
2. Outdoor or wet locations: NEMA 250, Type 3R.
3. Corrosive Environments: NEMA 250, Type 4X.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Provide sizes to match SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Factory install integral SPDs as part of the distribution equipment and connect through a disconnect.

1. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.

C. Provide a minimum 30A circuit breaker as required to comply with the UL listing of the SPD.

D. Install SPDs with properly rated conductors between suppressor and points of attachment as short and straight as possible with no sharp bends, and adjust circuit-breaker positions to achieve shortest and straightest leads.

E. Do not splice and extend SPD leads unless specifically permitted by manufacturer.

F. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

G. Twist input conductors together to reduce the input inductance.

H. Use crimped connectors and splices only. Wire nuts are not acceptable.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

SECTION 265000

LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. This section is intended to specify in conjunction with the Light Fixture Schedule, the luminaires, supports, accessories, specialties and related items necessary to complete the work as shown on the drawings.

B. Section Includes:
   1. Interior light fixture
   2. Exterior light fixtures including building mounted
   3. Exit signs
   4. LEDs and drivers
   5. Light fixture supports and accessories
   6. Light fixture poles and bases

1.3 COORDINATION

A. This work consists of providing all labor, materials, accessories, mounting hardware and equipment necessary for an operationally and aesthetically complete installation of all luminaires, including power wiring, control wiring and accessories, in accordance with the contract documents.

B. Contractor shall provide all luminaires, as herein specified, complete with lamps, drivers, power supplies, ballasts and accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.

C. Contractor shall coordinate all infrastructure requirements with all approved lighting equipment prior to infrastructure installation, including, but not limited to appropriately sized, positioned and located junction boxes, structural supports, feeds, power and control conduits, and remote code-compliant power-supply enclosures.

D. All available finishes and colors, for each luminaire, shall be submitted to the Architect for selection during shop drawing review. Premium finishes, where indicated, shall be provided at no additional cost premium.

E. Specifications and drawings are intended to convey all salient features, functions and characteristics of the luminaires only, and do not undertake to illustrate or set forth every item or detail necessary for the work. Minor details, not usually indicated on the drawings nor specified,

but that are necessary for proper execution and completion of the luminaries, shall be included, the same as if they were herein specified or indicated on the drawings.

F. The Owner, Architect and Engineer shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the light fixtures. The responsibility of accurately fabricating the light fixtures to the fulfillment of the specification rests with the Contractor.

G. Refer to architectural details, as applicable, for recessed soffit fixtures or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades. Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.

H. In accordance with the above and the criteria established herein, the Contractor is responsible for assuring the final design, fabrication and installation which fulfills the requirements of the Contract Documents.

1.4 REFERENCES

A. Abbreviations and Acronyms

1. CCT: Correlated color temperature
2. CRI: Color-rendering index
3. CU: Coefficient of utilization
4. IECC: International Energy Conservation Code
5. LER: Luminaire efficacy rating, which is calculated according to NEMA LE 5.
6. NRTL: Nationally Recognized Testing Laboratory
7. SPD: Surge Protective Device
8. RCR: Room cavity ratio.
9. UL: Underwriters Laboratory

B. Definitions

1. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in the IESNA Lighting Library.
2. Light Fixture (Luminaire): Complete lighting unit consisting of a lamp(s) and driver(s)/ballast(s) (when applicable) together with the parts designed to distribute the light, to position and protect the lamp(s), and to connect the lamps to the power supply.
3. Lumen: Delivered output of luminaire.
4. Total harmonic distortion (THD): The root mean square (RMS) of all the harmonic components divided by the total fundamental current.
5. Pole: Luminaire support structure, including tower used for large area illumination.
6. Standard: Same definition as "Pole" above.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version (including amendments, addenda, revisions, supplements, and errata) as of the date of the Contract Documents, unless otherwise specified.

1. Illuminating Engineering Society of North America (IESNA)
   a. IES LS-1-20, Lighting Science: Nomenclature and Definitions for Illuminating Engineering
2. National Electrical Manufacturer's Association (NEMA)
   a. NEMA SSL 1, Electronic Drivers for LED Devices, Arrays or Systems
   b. NEMA SSL 3, High-Power White LED Binning for General Illumination

1.5 SUBMITTALS

A. Product Data: For each type and model of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. All available finishes and colors for each luminaire type shall be submitted to the Architect for selection during review.
3. Life, output (lumens, CCT, and CRI), and energy-efficiency data for light fixtures.
4. Dimensions, effective projected area (EPA), accessories, installation details and construction details.
5. Poles: Include dimensions, materials, wind load determined in accordance with AASHTO, pole deflection, pole class, and other applicable information.
6. Distribution data according to IESNA classification type as defined in IESNA handbook.
7. Anchor bolts.
8. US DOE LED Lighting Facts Label and IESNA L70 rated life.
9. Amount of shielding on luminaires.
10. Control type: 0-10V, DMX, bi-level, etc.

B. Shop Drawings: Including plans, elevations, sections, details, and attachment to other work.

1. Include detailed equipment assemblies and indicate electrical ratings, dimensions, emergency section, control type, wiring, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal and control wiring.
3. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

C. Pole and Support Component Certification Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

D. Sample Warranty

E. Closeout Submittals

1. Maintenance Contract
2. Operation and Maintenance Data
3. Warranty Documentation
4. Record Documentation
5. Sustainable Design Closeout Documentation
6. Software

1.6 MAINTENANCE MATERIAL

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

1. Single Sided Exit Sign: One for every 15 of each type. Furnish at least two of each type.
2. Double Sided Exit Sign: One for every 15 of each type. Furnish at least one of each type.
3. LED Drivers: One for every 50 of each type and rating installed. Furnish at least 5 of each type.
4. LED Lamps/Boards: One for every 100 of each type and rating installed. Furnish at least two of each type.

1.7 QUALITY ASSURANCE

A. In each of the publications referred to herein, consider the advisory provisions to be mandatory.

B. Manufacturer Qualifications: Equipment shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

C. Where groups of luminaire types exhibit the same list of acceptable Manufacturers, such as downlights, accents, and wall washers, the intent is to have a final installation with the same Manufacturer's equipment across the groupings as specified for consistency of optics, aesthetics, and similarity of maintenance procedures. Mixing/matching across groups is unacceptable. This also applies to multi-phased projects with single or multiple, but related luminaire types exhibiting the same list of acceptable Manufacturers, except where products have subsequently been discontinued or significantly redesigned in size, appearance, lamping, or gear. Lamps shall be from a single manufacturer and batch.

1.8 DELIVERY, STORAGE AND HANDLING:

A. The Contractor shall provide, receive, unload, uncrate, store, protect and install lamps, luminaires and auxiliary equipment, as specified herein, in accordance with respective manufacturers' project conditions of temperature and humidity and with appropriate protection against dust and dirt. Lamps for miscellaneous equipment shall be provided and installed by the Contractor according to equipment manufacturers' guidelines.

B. All products shall be stored in manufacturer's unopened packaging until ready for installation.

C. Luminaire Poles: Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Support poles to prevent distortion and arrange to provide free air circulation. Retain factory-applied pole wrappings on poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.9 COORDINATION

A. Coordinate layout and installation of exterior lighting fixtures with all other construction including all underground utilities and geothermal well fields.

B. Coordinate layout and installation of lighting fixtures with all other construction that penetrates ceilings or is supported by them, including HVAC equipment, plumbing, fire-suppression system and partition assemblies.

C. Contractor shall coordinate all infrastructure requirements with all approved lighting equipment prior to infrastructure installation, including, but not limited to appropriately sized, positioned and located junction boxes, structural supports, feeds, power and control conduits, and remote code-compliant power-supply enclosures.

D. Prior to procurement of light fixtures:
   1. Confirm application and required voltage.
   2. Confirm the proper and complete catalog number with distributor and agent.

3. Ensure wiring, driver, etc meets the specifications and proper requirements.
4. Provide additional parts and pieces required to complete the installation in the location and manner intended by the design.

E. Light fixture locations in mechanical and electrical equipment rooms/areas are approximate. Locate light fixtures to avoid equipment, ductwork, and piping. Locate around and between equipment to maximize the available light. Coordinate mounting heights and locations of light fixtures to clear equipment. Request a meeting with the Engineer if uncertain about an installation.

F. Coordinate between the electrical and ceiling trades to ascertain that approved luminaires are furnished in the proper sizes, with the proper flange details, and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed.

1.10 WARRANTIES

A. Manufacturer Warranty: All luminaries, finishes, poles, batteries, supports, accessories and all of its component parts, workmanship, and controls shall have an unconditional five (5) year on-site replacement warranty. Warranty shall include all light fixtures, lamps, drivers, poles, finishes and all components to be free from defects in materials and workmanship for a period of five (5) years from date of Owner's acceptance. On-site replacement includes transportation, removal, and installation of new products. Replacement of luminaries, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.
1. Luminaires: Five (5) years from date of substantial completion.
2. LED drivers: Ten (10) years from the date of substantial completion. The warranty shall state the malfunctioning LED driver shall be exchanged by the manufacturer and promptly installed by the Contractor. The replacement LED driver shall be identical to, or an improvement upon, the original design of the malfunctioning LED driver.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

B. Comply with NFPA 70.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of Design for each light fixture type shall be the first fixture manufacturer and model number for each type listed.

B. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Report any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

C. All luminaires shall be DLC (Design Lights Consortium) or Energy Star Certified.

2.3 EQUAL MANUFACTURERS

A. Manufacturers listed as "Equal" to the Basis of Design on the light fixture schedule shall submit product cutsheets to the Engineer prior to bid for final written approval. This written approval will only be issued in addendum form. "Equal" fixtures shall be of equal or better quality and performance to the fixture(s) listed with manufacturer's model numbers. Burden of proof shall be on the Contractor, Vendor and manufacturer.

B. Upon request by Engineer, the Contractor shall submit manufacturer's computerized horizontal illumination levels using AGI32 software in footcandles at workplane (30" above finished floor), taken every 3 feet in every interior room and area. Include average maintained footcandle levels and maximum and minimum ratio.

C. Upon request by Engineer, the Contractor shall submit manufacturer's computerized horizontal illumination levels using AGI32 software in footcandles, taken every ten (10) feet at grade for the entire exterior site. Include average maintained footcandle levels and maximum and minimum ratio.

D. Refer to specification Section 260010 "General Requirements for Electrical Systems" for additional requirements.

2.4 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

A. Complete luminaires shall be in accordance with NFPA 70, NEMA, and UL 1598 listed and labeled.

B. Ballasts, drivers, or transformers, unless otherwise specified, shall be field replaceable and shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.

C. Luminaires shall be entirely factory wired by the luminaire manufacturer in accordance with code and UL requirements and shall be furnished fully compatible with the project electrical wiring and controls system for smooth, continuous, dimming or on/off flicker-free operation.

D. Exterior building mounted light fixtures shall be UL classified for damp or wet locations as applicable and shall be complete with gaskets, cast aluminum outlet box and grounding. Luminaires shall be suitably gasketed and vented according to manufacturer's instructions. All dissimilar metal materials shall be separated by non-conductive materials to prevent galvanic action.

E. All luminaires supplied for recessing in suspended ceilings shall be supplied with pre-wired junction boxes, unless otherwise specified.

F. Metal parts: Free of burrs, sharp corners and sharp edges.

G. Doors, frames and other internal access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers and other components from falling accidently during maintenance and when secured during operating position.

H. Mounting Frames and Rings: If ceiling system and luminaire type requires, each recessed and semi-recessed luminaire shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed as coordinated by Contractor. The frames and rings shall be one piece and of sufficient size and strength to sustain the weight of the luminaire and maintain plumb. Luminaires shall be braced such that the force required to close and/or latch lens or door frame does not lift or shift luminaire.

I. Pendant Supports: Contractor shall be responsible for coordination with Manufacturer, Architect, Structural Engineer and related trades to ensure that proper and adequate structural reinforcement is provided within ceilings to support pendant mounted lighting equipment for a secure, neat, square, plumb appearance. Pendants shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

J. Wall Bracket (Sconce) Supports: Contractor shall be responsible for coordination with Manufacturer, Architect, Structural Engineer and related trades to ensure that proper and adequate structural reinforcement is provided within walls to support wall mounted lighting equipment for a secure, neat, square, plumb appearance. Wall brackets shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

K. All lenses or other light diffusing elements shall be removable for access to lamp and electrical and electronic components and luminaire cleaning, however, they must otherwise be positively and securely held in-place, unless otherwise specified.

L. All lens door or holder trim flanges shall fit plumb and flush with the ceiling or wall surface. There shall be no light leaks around the interface between lens door or holder trim flanges and the ceiling or wall.

M. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility.

N. Recessed luminaires mounted in an insulated ceiling shall be listed for use in insulated ceilings, IC-rated, or provisions made to maintain code-compliant 3" air-space around luminaires in accordance with Manufacturers' instructions.

O. Mechanical Safety: Unless otherwise specified, luminaire closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

P. Unless otherwise specified, luminaires with louvers or light transmitting panels shall have hinges, latches and safety catches to facilitate safe, convenient cleaning and re-lamping. Vapor tight luminaires shall have stainless steel pressure clamping devices.

Q. Yokes, brackets and supplementary supporting members necessary for mounting lighting equipment shall be furnished and installed by the Contractor and approved by the Architect. All materials, accessories, and any other equipment necessary for the complete and proper installation of luminaires, lamps, ballasts/neon transformers included in the contract shall be furnished and installed by the Contractor. All yokes, brackets and supplementary supports shall provide a neat, square, plumb and level appearance, and shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with all lamps, globes, lenses, lens frames or doors etc. in place.

R. All connections shall be fixed rigid by screws, rivets and/or soldering. Screws and rivets shall not be visible except as necessary for maintenance and/or aesthetic appearance. All connections shall provide a neat, square, plumb and level appearance, and shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

S. All housings shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal and the luminaire styling. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly.

T. For steel and aluminum luminaires, all screws, bolts, nuts and other fastening and latching hardware shall be a cadmium or equivalent plated. For stainless steel luminaires, all hardware shall be stainless steel. For all bronze luminaires, all hardware shall be bronze.

U. Extruded aluminum frames and trims shall be rigid and manufactured from quality aluminum without blemishes in the installed product. Miter cuts shall be accurate; joints shall be flush and without burrs and cut alignment maintained with the luminaire located in its final position.

V. Castings shall exactly replicate the approved pattern(s) and shall be free of sand pits, blemishes, scales and rust and shall be smoothly finished, excepted as necessary for an authentic historic appearance and as agreed by Architect. Tolerances shall be provided for any shrinkage in order that the finished castings accurately fit their locations resulting in plumb and level fit and consistently tight-seamed fittings.

W. Luminaires in Hazardous Areas: Luminaires shall be suitable for installation in flammable atmospheres (Class and Group) as defined in NFPA 70 and shall comply with UL 844.

X. Each light fixture shall be packaged with complete instructions and illustrations on how to install.

Y. Each light fixture box, container, etc shall be labeled at the factory with the type designation as indicated on the Light Fixture Schedule.

Z. Provide factory cut custom stem lengths, as required.

AA. Exit signs and fixtures that are hatched or where the fixture type contains the suffix "E" for emergency operation, the fixture shall have an integral 90-minute battery inverter if not powered from an emergency generator.

BB. All battery powered fixtures shall have test switches factory installed integral to the reflector. Remote test switches will not be accepted.

2.5 LUMINAIRE REFLECTORS AND TRIMS

A. Alzak cones, reflectors, baffles and louvers shall be warranted against discoloration.

B. All trims, reflectors and canopies shall fit snugly and securely to the ceiling or wall so that no light leak occurs.

C. Trims shall be self-flanged, unless otherwise specified.

D. For trimless or flangeless luminaires, Contractor shall coordinate with other Trades to achieve a trimless/flangeless installation acceptable to the Architect. Where ceilings are drywall or plaster,

this involves Level 5 finishes or as otherwise directed by the Architect. In drywall, plaster, wood, or stone ceilings, special luminaire collars and exacting coordination are required of Contractor.

2.6 LIGHT EMITTING DIODE (LED) ELECTRONIC DRIVERS

A. The electronic drivers shall as a minimum meet the following characteristics:
1. LED drivers shall comply with NEMA SSL 1, NFPA 70, and UL 8750 unless otherwise specified.
2. Drivers remote from luminaires shall be housed in NEMA enclosures so rated for the driver and located in code-compliant, sound-isolated, well-ventilated and easily accessible areas. Wire shall be sized according to run length and LED Manufacturer's size and distance-of-run requirements and all in accordance with all code requirements.
3. Driver shall comply with UL 1310 Class 2 requirements for dry and damp locations, NFPA 70 unless specified otherwise. Drives shall be designed for the wattage of the LEDs used in the indicated application. Drivers shall be designed to operate on the voltage system to which they are connected.
4. LED driver shall withstand up to a 1,000-volt surge without impairment of performance as defined by ANSI C62.41 Category A.
5. LED driver shall tolerate ±10 percent supply voltage fluctuation with no adverse effects to driver or LEDs.
6. Drivers for luminaires controlled by dimming devices shall be as specified herein and equipped for dimming and conform to the recommendations of the manufacturer of the associated dimming devices to assure satisfactory operation of the lighting system. Contractor shall coordinate all wiring infrastructure to accommodate final-selected drivers and controls systems for smooth, continuous, and flicker-free operation.
7. Flicker: The flicker shall be less than 5 percent at all frequencies below 1000 Hz and without visible flicker.
8. Provide with short circuit, open circuit and overload protection.
9. Drivers shall meet or exceed NEMA 410 driver inrush standard.
10. Total Harmonic Distortion shall be less than 20 percent.
11. Power Factor to be greater than 95%
12. Drivers to be reduction of hazardous substances (ROHS) compliant

2.7 LIGHT EMITTING DIODE (LED)

A. The light emitting diodes shall as a minimum meet the following characteristic:

1. LED lamps shall comply with ANSI C78.1, IESNA LM-79 and IESNA LM-80.
2. Light emitting diodes shall be tested under IES LM-80 standards.
3. Color Rendering Index (CRI) shall be 84 (minimum).
4. Rated lumen maintenance of 90% lumen output at 50,000 hours (minimum).
5. Rated lumen maintenance of 70% lumen output at 100,000 hours (minimum).

2.8 SUSPENDED LUMINAIRES

A. Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers shall allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging. Single-unit suspended fixtures shall have twin-stem hangers. Multiple-unit or continuous row fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for

each unit length of chassis, including one at each end. Rods shall be a minimum 0.18 inch diameter.

B. All suspended luminaires with a weight in excess of 50 pounds shall be fitted with safety cable of sufficient strength and length to meet all UL safety cable load-bearing requirements. Cable shall exhibit a finish (but not painted) compatible with that of the metal finish of the stem/chain/suspension-cable assembly or alternatively finished in black as approved by Architect. Shop drawings shall indicate luminaire weight. Contractor shall coordinate structural support/attachment requirements including independent structure for safety cable attachment with Vendor, Architect, and Structural Engineer and all respective trades. Safety cable shall exhibit sufficient length to wrap tightly and entirely around structural member at least twice before attachment subject to Vendor confirmation of UL requirements and pending Structural Engineer review. Contractor shall provide labor necessary for the stem/chain-assembly-wiring-threading and safety-cable-attachment as instructed by Vendor.

2.9 DOWNLIGHT FIXTURES AND COMPONENTS

A. Downlights shall be listed for thru-branch circuit wiring, recessing in ceilings and damp locations.

B. Where installed in plaster or drywall or other inaccessible ceiling types, they shall be UL listed for bottom access.

C. Provide with tool-less hinged junction box access cover and thermal protection accessible from below through reflector opening.

D. Provide telescoping channel bar hangers that adjust vertically and horizontally.

2.10 EXIT SIGNS

A. General requirements: Comply with UL 924, NFPA 70, AND NFPA 101.

B. All exit signs shall be LED type.

C. Provide single or double face as scheduled, indicated on plans or as required by the local Authority Having Jurisdiction. Adjust installation position if required for clear visibility, in accordance with applicable codes.

D. Provide directional arrows (chevrons) as indicated on floor plans and to suit the means of egress or as required by the local Authority Having Jurisdiction.

E. Where emergency backup battery packs are provided with exit lights, they shall have capacities for continuous operation per applicable codes. All exit signs with battery backup shall be provided with self-diagnostics.

F. Complete unit to be furnished in color/finish as selected by the Architect.

2.11 EMERGENCY INVERTER

A. Description: Stand alone, modular, modified sine wave output battery-inverter unit, remote mounted from luminaire. Complying with UL924.
   1. Provide a minimum of 90 minutes of battery back-up upon loss of power.

2. Power Output: suitable for powering designated emergency light fixtures.
3. Battery: Sealed, maintenance-free, nickel-cadmium or lead-acid type.
4. Charger: Fully automatic, solid-state, constant-current type.
5. Operation: Solid state switching circuit automatically turns connected fixtures on upon absence of power-supply circuit voltage and switches back to normal operation upon restoration of AC power.
6. Steel Housing: Type 1 enclosure listed for installation inside, on top of, or remote from luminaire.
7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.12 LUMINAIRE SUPPORT HANGERS AND COMPONENTS

A. Wires: ASTM A641/A641M, Class 3, soft temper, galvanized regular coating, 0.1055 inches in diameter (12 gage).

B. Straps: Galvanized steel, one by 3/16 inch, conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

C. Rod Hangers: Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.13 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Provide poles designed for site specific wind loading (minimum of 120 miles per hour) determined in accordance with AASHTO LTS while supporting luminaires and all other appurtenances indicated. The effective projected areas of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole. Poles shall be anchor-base type designed for use with underground supply conductors. Poles shall have full base metal covers with matching finish to conceal the mounting hardware, pole-base welds and anchor bolts.

B. Structural Characteristics: Comply with AASHTO LTS
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.3 to obtain the equivalent projected area to be used in pole selection strength analysis.

C. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners, unless otherwise indicated.

D. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

E. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

F. Pole Base Concrete Foundations:
   1. Cast in place, with anchor bolts to match pole-base flange. Anchor bolts shall be steel rod having minimum yield strength of 50,000 psi and shall be galvanized in accordance with ASTM A153/A153M. Concrete shall be as specified in Division 03 Section, Cast-In-Place Concrete.
   2. Use 4000-psi, 28-day compressive-strength concrete unless otherwise noted. Comply with Division 03 Section "Cast-in-Place Concrete" and ACI standards for subbase requirements, concrete materials, reinforcement, placement, and cover requirements.

G. Breakaway Supports: Provide frangible breakaway supports where noted on plans, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS.

H. Brackets and Supports
   1. ANSI C136.3, ANSI C136.13, and ANSI C136.21, as applicable. Pole brackets shall be not less than 1-1/4 inch secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 24 feet above street. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with luminaire head. Detachable, cantilever, without underbrace.

I. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

J. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire.

K. Finish: Same as luminaire.

2.14 INTERNAL DISCONNECT

A. All luminaires shall be provided an internal disconnect. Fixtures with a remote driver to have disconnect at driver location.

2.15 POLE ACCESSORIES

A. Duplex Receptacle: Where indicated on plans, provide 120 V, 20 A receptacle in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for a weather resistant, ground-fault circuit-interrupter type. Recessed, 12 inches above pole base. Weatherproof, metal, in-use cover, color to match pole, that when mounted results in NEMA 250, Type 4X enclosure with cord opening and lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
   1. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover for poles supplied by voltage other than 120 V.

B. Base Covers: Provide Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

2.16 FACTORY APPLIED FINISH

A. Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

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

3.2 INSTALLATION

A. Architect's reflected ceiling plan (RCP) indicates actual locations of all light fixtures, diffusers and system devices. Report to the Architect/Engineer any conflicts. Do not scale plans for exact location of lighting fixtures.

B. Coordinate mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed.

C. Install luminaires in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA, and NEMA standards.

D. Installed luminaires shall be provided with protective covering by Contractor until such time as the space(s) is cleaned and ready for occupancy.

E. Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secured in accordance with manufacturers' directions and approved drawings.

F. Lighting Fixture Supports:

1. Comply with Section 260500, Common Work Results for Electrical Systems.
2. Sized and rated for luminaire weight.
3. Shall maintain the fixture positions after cleaning and re-lamping.
4. Ensure that the luminaires are supported such that there is no resultant bowing or deflection of the ceiling or wall system.
5. Capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

G. Recessed, semi-recessed and surface fixtures shall be independently supported from the buildings structure. Do not support any luminaire solely from ceiling grid or ceiling. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures.

H. Ceiling Grid mounted light fixtures:

1. Lighting fixtures installed in suspended ceilings shall also comply with the requirements of Division 09 Specification Sections for ceilings.
2. Support fixtures with two (2) wires with one (1) at each corner, per electrical detail.
3. Hanger wires: Install within 15 degrees of plumb or additional support shall be provided. Wires shall be attached to fixture body and to the building structure (not to the supports of other work or equipment). Where building structure is located such that 15 degrees cannot be maintained, provide "strut" or similar supports secured to structure to meet this requirement.
4. Support Clips: Provide four (4) clips per fixture minimum. Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application. Install clips per manufacturer's requirements. If screws are required, they shall be provided. Installation shall meet applicable seismic codes.
5. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at least two 3/4-inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture.
6. Downlights, exit signs and battery pack supported by or attached to ceiling grid or tile shall be provided with one hanger wire at each end. Provide a minimum of two, located at opposite corners.
7. Round fixtures or fixtures smaller in size than the ceiling grid shall be independently supported from the building structure by a minimum of four wires per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels.

I. Suspended fixtures:

1. Hang plumb and shall be located with no obstructions within the 45 degree range in all directions. The stem, cable, canopy and fixture shall be capable of 45 degree swing.
2. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints. Steel fixtures shall be supported to prevent "oil-canning" effects.
3. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel.
4. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown.
5. Whenever a luminaire or its hanger canopy is installed directly to a surface mounted junction box, a finishing ring painted to match the ceiling, shall be used to conceal the junction box.

J. Wall mounted fixtures:

1. Do not attach light fixtures directly to gypsum board.
2. Attach to structural members in walls or backing plate attached to wall structural members.

K. Rigidly align continuous rows of light fixtures for true in-line appearance.

L. Exit Signs and Emergency Lighting Units: Wire exit signs ahead of the switch to the un-switched branch circuit located in the same room or area. Connect to emergency system branch circuit where applicable.

M. Where emergency battery packs are provided with fixtures (if any), they shall be connected to an un-switched power line and wired in accordance with applicable codes and the manufacturer's recommendations.

N. Light fixture whips shall be independently supported from the building structure. Do not clip to lay-in ceiling support wires. Independent support wires shall be distinguishable by colors, tagging, or other effective means.

O. Exterior Fixtures:

1. Exterior building mounted light fixtures shall not be installed until after the building exterior has been rinsed clean of any corrosive cleaning materials. Damaged fixtures shall be replaced by the Contractor at no cost.
2. Provide exterior rated weather proof junction boxes for all fixtures and splices.
3. Utilize weatherproof silicone filled wire nuts and seal all junction boxes and conduit with potting compound to create waterproof barriers. Inspect all splices and fixtures for continuity prior to potting.
4. Lubricate all threaded parts with a high temperature waterproof anti-seize lubricant to prevent seizing and corrosion.
5. All low-voltage wiring to be UV resistant, UL approved for use without conduit, stranded low-voltage wire for use in outdoor and underground applications, gauge as appropriate to avoid voltage drop.
6. Provide surface mounted fixtures with conduit hub for end of fixture entrance.

P. Transformers (applies to all transformers including (but not limited to) low voltage, neon, remote ballast, LED power supplies, exterior locations):

1. Electrical Contractor to locate all transformers (including low voltage, neon, remote ballasts, led power supplies, etc.) near fixtures in a well-ventilated and accessible location. Transformers must be installed (per codes) in accessible areas large enough to dissipate the heat of the transformer. Temperatures should not exceed 100°F (38°C) or that required by manufacturer if more stringent.
2. Electrical Contractor to determine wire size according to load and wire length to eliminate voltage drop. If voltage drop is a problem after installation, the Electrical Contractor is responsible for reinstallation (at no additional cost) of transformer and wire to solve problem.
3. Electrical Contractor to label front of transformer/driver. Example: "Large Display Case @ Entry to Main Dining Room."

Q. Seal all knock-outs, conduit, and wire entrances for all luminaires in wet and damp locations to prevent water wicking.

R. All reflecting surfaces, glass or plastic lenses, ballast housings, parabolic louvers, downlighting alzak cones and specular reflectors and other decorative elements shall be installed after completion of ceiling tile installation, plastering, painting and general cleanup.

S. Handle all reflecting surfaces, glass or plastic lenses, ballast housings, parabolic louvers, downlighting alzak cones and specular reflectors and other decorative elements with care during installation or lamping to avoid fingerprints or dirt deposits.

T. Luminaires installed and used for working light during construction shall be replaced prior to turnover to the Owner if more than 3 percent of their rated life has been used. Fixtures shall be tested for proper operation prior to turn-over and shall be replaced if necessary.

3.3 POLE, LIGHT COLUMN AND BOLLARD INSTALLATION

A. Alignment: Align foundations, poles light columns and bollards for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet
   3. Trees: 15 feet from tree trunk.

C. Excavation: Restrict excavation in size to that which will provide sufficient working space for installation of concrete forms. Should soil conditions at the bottom of the excavation be unsuitable as a foundation, as determined by the Architect, take the excavation down to firm soil and fill to required grade with concrete or satisfactory soil materials as directed.

D. Backfill: Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell.

E. Concrete Pole Foundations:
   1. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
   2. Concrete Pole Foundations shall be cast-in-place concrete, having 3000 psi minimum 28-day compressive strength.
   3. Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.
   4. Formwork: Construct forms of wood, plywood, steel, or other acceptable materials fabricated to conform to the configuration, line, and grade required. Reinforce formwork to prevent deformation while concrete is being placed and consolidated. Wet or coat formwork with a parting agent before placing concrete.
   5. Cast conduit into concrete pole foundations.
   6. Prior to concrete pour, install a ground rod and a separate insulated equipment grounding conductor at each pole, light column and bollard in addition to grounding conductor installed with branch-circuit conductors.
   7. Finish by troweling and rubbing smooth. Round all above-grade concrete edges to approximately 0.25" radius.
   8. Refer to Pole Base Detail on drawings for additional requirements.

F. Foundation-Mounted Poles:
   1. Install according to pole manufacturer's instructions using a template supplied by pole manufacturer in accordance with the lighting standard manufacturer's recommendations.
   2. Use galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end, and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   3. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
   4. Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer. Provide base covers.

G. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
   1. Dig holes large enough to permit use of tampers in the full depth of hole.
   2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

H. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
   1. Make holes 6 inches in diameter larger than pole diameter.
   2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.

3. Use a short piece of 1/2-inch diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

I. Poles and Pole Foundations Set in Concrete Paved Areas (Slabs): Install poles with minimum of 6-inch wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

J. Raise and set poles using web fabric slings (not chain or cable). Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location. Alterations to poles after fabrication will void manufacturer's warranty and shall not be allowed.

K. Bollard and light column luminaire installation:
1. Install on concrete base with top level with finished grade or surface at luminaire location. Shape base to match shape and diameter of bollard and/or light column base.

3.4 GROUND-MOUNTING LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location.

3.5 IN-GRADE LUMINAIRE INSTALLATION

A. All in-grade fixtures shall be installed per manufacturer's installation instructions.

B. Verify design type, Flow Through or Sealed, prior to installation.

C. Flow Through in-grades fixtures shall have drainage system installed below fixture per manufacturer's requirements. If site has poor drainage soil, a sealed in-grade shall be installed. Coordinate soil type with civil engineer prior to submittals.

D. Provide all conduit connections to in-grade fixture with seal off compound.

3.6 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

3.7 GROUNDING

A. Comply with Section 260526

B. Bond luminaires and metal accessories to the grounding system per NEC.

C. Ground noncurrent-carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

D. At each light pole, light column, light bollard and support structures, provide a driven ground rod into the earth so that after the installation is complete, the top of the ground rod will be approximately 1 foot below finished grade. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Light fixtures served from multiple power sources, such as emergency fixtures fed from emergency transfer relay or split wired fixtures, shall have the following label affixed to it: “DANGER - ELECTRICAL SHOCK HAZARD - LIGHT FIXTURE HAS MULTIPLE POWER SOURCES”

B. Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

C. Factory-Applied Labels: Provide labeled luminaires in accordance with UL 1598 requirements. All light fixtures shall be clearly marked for operation of specific LED’s and drivers according to proper type. The following characteristics shall be noted in the format "Use Only _____":

1. LED or lamp type, and nominal wattage
2. Driver or ballast type
3. Correlated color temperature (CCT) and color rendering index (CRI)
4. All markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Drivers and ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

3.9 FIELD QUALITY CONTROL:

A. The lighting and lighting controls systems shall be synchronized and fully operable to address the lighting operation in a complete and code-compliant manner.

B. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section. Replace defective light fixtures, controls, lamps, ballasts and drivers at no cost to Owner.

C. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal and emergency power sources.

D. Illumination Tests:

1. Measure light intensities at night. Use certified photometers with calibration referenced to NIST standards. Record footcandle results and furnish to the Engineer. Comply with the following IESNA testing guide(s):
   a. IESNA LM-5, “Photometric Measurements of Area and Sports Lighting Installations.”
   b. IESNA LM-50, “Photometric Measurements of Roadway Lighting Installations.”
   c. IESNA LM-52, “Photometric Measurements of Roadway Sign Installations.”
   d. IESNA LM-64, “Photometric Measurements of Parking Areas.”
   e. IESNA LM-72, “Directional Positioning of Photometric Data.”

E. Dimming Drivers. Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range. Replace defective light fixtures, controls, lamps, ballasts and drivers at no cost to Owner.

F. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal. Replace defective light fixtures at no cost to Owner.

G. Inspect each light fixture for damage. Replace damaged light fixtures at no cost to the Owner.

H. Fixtures showing dirt, dust or fingerprints shall be restored to like new condition or shall be replaced at no cost.

3.10 CLEANING

A. At completion of each phase and the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturer.

B. All fingerprints, dirt, tar, smudges, drywall mud and dust, etc. shall be removed by the Contractor from the luminaire bodies, reflectors, trims, and lens/louvers prior to final acceptance. Cleaned with solvent recommended by the manufacturer to a like-new condition or replaced. All reflectors shall be free of paint other than factory-applied, if any.

3.11 ADJUSTING

A. All adjustable luminaires shall be aimed, focused, locked, etc., by the Contractor under the observation of the Architect and Engineer. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely by the Contractor. All aiming and adjusting shall be performed after the entire installation is complete for each phase or area. The Contractor shall be responsible for notifying the Architect of appropriate time for final luminaire adjustment. Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing lighting effects, aiming shall be accomplished at night at no premium cost.

B. All ladders, scaffolds, lifts, gloves, cleaning cloths, access/adjustment tools, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.

C. Occupancy Adjustments: When requested within 12 months of date of Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust aimable luminaires in the presence of Architect/Engineer.

END OF SECTION

DIVISION 27 – COMMUNICATIONS

SECTION 270000 – VOICE/DATA SYSTEM

PART 1 - GENERAL SPECIFICATIONS

1.1 RELATED DOCUMENTS

A. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

B. The use of proprietary or copyrighted names or reference to patented trade items within this specification or elsewhere in the Contract Documents is meant to establish a standard of quality and performance. In no way does such use establish a restrictive competitive bidding situation, or exclude materials or equipment that is truly equivalent to the standard of quality. All materials and equipment proposed for installation must meet or exceed all specified requirements and be approved. Known equals are listed, but will require cut sheets with performance parameters to be submitted for final approval at least 10 days prior to bid.

1.2 SUMMARY

A. Section Includes:

1. Work Area Outlets
2. 110 Copper Termination Block & Patch Panels
3. Racks, Cabinets and Cable Management
4. Horizontal Distribution Cable
5. Backbone & DAS Cabling Cable
6. Fiber Optic Termination Hardware
7. Patch Cords and Fiber Jumpers
8. Pathways & Penetrations
9. Audio Visual Infrastructure
10. Power (UPS and PDU)
11. Grounding and Bonding
12. Copper Cable Protection Units
13. Firestopping
14. Cable System Identification System

1.3 SCOPE OF WORK

A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings. Work shall consist of

1. Work area outlets including faceplates, jacks (voice, data, CATV, A/V), and labels. Boxes and conduit are being provided by Div 26 contractor.
2. Voice and data copper station cabling from work area outlets to telecommunications rooms including termination testing and labeling.
3. Voice and data work area equipment cords.
4. Voice and data horizontal cross-connect jumpers and patch cables including labeling.

B. System Description -- Voice and Data station cabling (copper) system shall consist of:
   1. Workstation outlet jacks.
   2. Voice and data station cabling as specified herein from each workstation outlet to the termination equipment located in the Main Distribution Frame (MDF) or the Intermediate Distribution Frame (IDF).
   3. Station Cable Termination Equipment in each MDF and IDF.
   4. Final connections of the station cabling at the workstation outlet jack and the termination equipment in each MDF and IDF.
   5. Cross connects / patch cable to connect work area outlets to backbone / network electronics.
   6. Testing and labeling.

1.4 REGULATORY REFERENCES:

A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the local Electrical Code and present manufacturing standards.

B. All materials shall be UL or ETL Listed and shall be marked as such. If UL/ETL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL/ETL has an applicable system listing and label, the entire system shall be so labeled.

C. All modular jacks, patch cords, consolidation point, and patch cords performance shall be verified (not just tested) by a third party to be category 6 (or 6A) component and channel compliant.

D. The cabling system described in this is derived from the recommendations made in recognized telecommunications industry standards. The following documents are incorporated by reference:

   1. ANSI/TIA-568.0-D, Generic Communications Cabling for Customer Premises, September 2015
   2. ANSI/TIA-568.1-D, Commercial Building Communications Infrastructure Standard September 2015
   3. ANSI/TIA-568.2-D, Balanced Twisted-Pair Telecommunications Cabling and Components Standard, September 2018
   4. ANSI/TIA-568.3-D, Optical Fiber Cabling Components Standard, September 2016
   5. ANSI/TIA–569-D, Telecommunications Pathways and Spaces, November 2015
   6. ANSI/TIA–606-C, Administration Standard for Communications Infrastructure, June 2017
   7. ANSI/TIA–607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, November 2015
   8. ANSI/ TIA–758-B, Customer-Owned Outside Plant Telecommunications Infrastructure Standard, March 2014.
   9. ANSI/TIA-1179-A, Healthcare Facilities Telecommunications Infrastructure Standard, August 2017
   10. BICSI - TDMM, Building Industries Consulting Services International, Communications Distribution Methods Manual (TDMM) – 13th Edition.
   11. National Fire Protection Agency (NFPA – 70)
   12. FCC 47 CFR 68
   13. NEMA 250
   14. NEC 2017
   15. ADA, Americans with Disabilities Act

E. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

F. This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

1.5 APPROVED VENDORS

A. The Installation Vendors (Contractors) must at a minimum possess the following qualifications:

1. Be in business a minimum of five (5) years
2. Shall demonstrate satisfaction of sound financial condition and shall be adequately bonded and insured per owner's requirements.
3. Possess those licenses/permits required to perform communications installations in the specified jurisdiction
4. Personnel knowledgeable in local, state, province and national codes and regulations. All work shall comply with the latest revision of the codes and regulations. When conflict exists between local and national codes or regulations, the most stringent codes or regulations shall be followed.
5. Must possess and provide proof of current owners insurance certificates
6. Installers with RCDD on staff are preferred, at least one BICSI certified technician required.
7. Must have prior experience with this type of installation or work activity. The customer may, with full cooperation of the contractor, visit client installations to observe equipment operations and consult with references. Specified visits and discussion shall be arranged through the contractors; however, the contractor's personnel shall not be present during discussions with references. The contractor must provide a minimum of three (3) references of similar jobs, one within the past 6 months and one at least 3 years ago where the same solution was installed.
8. Documentation of ALL certifications to be provided in bid package
9. Outside Plant Projects – will be done by pre approved vendor according to demographic and size of project

1.6 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. The Telecommunications contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install a complete telecommunications wiring infrastructure.
2. Furnish, install, and terminate all UTP and Optical Fiber cable
3. Furnish and install all wall plates, jacks, patch panels, and patch cords.
4. Furnish and install all required cabinets and/or racks as required and as indicated.
5. Furnish any other material required to form a complete system.

6. Furnish and install j-hooks where needed for the horizontal distribution
7. Furnish and install all materials to build out the MDFs/IDFs as depicted on drawings
8. Telecommunications contractor is responsible for the basket tray in MDFs/IDFs. The basket tray for the horizontal distribution may be done by or in coordination with the electrical contractor
9. Perform link testing (100% of horizontal and/or backbone links/channels) and certification of all components.
10. Furnish test results of all cabling to the owner electronically, listed by each closet, then by workstation ID.
11. Adhere and comply with all requirements of Manufacturer Certification.
12. Provide owner training and documentation. (Testing documentation and As-built drawings)

1.7 SUBMITTALS

A. Under the provisions of this request for proposal, prior to the start of work the telecommunications contractor shall:

1. Submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof of compliance of this spec.
2. Submit proof from manufacturer of contractor's good standing in manufacturer's program.
3. No substitutions/alternatives from the manufacturers listed in this document will be permitted. No substituted materials shall be installed except by written approval.
4. Product Data: For each type of product indicated.
    a. Submittals shall include manufacturer's data sheets (cut sheets) and be accompanied by a detailed bill of material, including part numbers and quantities.
5. Shop Drawings:
    a. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
    b. Wiring diagrams to show typical wiring schematics including the following:
        1) Cross-connects.
        2) Patch panels.
        3) Patch cords.
    c. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
    d. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
        1) Vertical and horizontal offsets and transitions.
        2) Clearances for access above and to side of cable trays.
        3) Vertical elevation of cable trays above the floor or bottom of ceiling structure.
        4) Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
6. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
7. Source quality-control reports.
8. Field quality-control reports.
9. Maintenance Data: For connectors to include in maintenance manuals.

B. Work shall not proceed without the Owner's approval of the submitted items.

1.8 QUALITY ASSURANCE

A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. The contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not. All installers must be employees of the contractor.

1.9 DELIVERY, STORAGE AND HANDLING

A. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from theft, vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location. If necessary, cable shall be stored off site at the contractor's expense.
B. If the telecommunications contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner.

1.10 DRAWINGS

A. It shall be understood that the electrical details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the telecommunications contractor in bidding the job. The telecommunications contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.
B. The contractor shall verify all dimensions at the site and be responsible for their accuracy.
C. Prior to submitting the bid, the telecommunications contractor shall call the attention of the Engineer to any materials or apparatus the telecommunications contractor believes to be inadequate and to any necessary items of work

1.11 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers.
   1. Meet jointly with telecommunications and LAN equipment suppliers, Engineer, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust arrangements and locations of racks, sleeves, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of utility demarcation, telephone and LAN equipment.
B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 EQUIVALENT PRODUCTS

A. Due to the nature and type of communications all products and solutions in this document have a standard of quality listed. Substitutions are listed, but products MUST demonstrate performance equivalency.

2.2 WORK AREA OUTLETS

A. Work area cables shall each be terminated at their designated work area location in the connector types described in the subsections below. Included are modular telecommunication jacks. These connector assemblies shall snap into a faceplate.

B. The Telecommunications Outlet Assembly shall accommodate:
   1. A minimum of two (2) modular jacks unless specified. Additional copper cables as necessary. Drawings take precedence.
   2. A blank filler will be installed when extra ports are not used.
   3. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.
   4. The modular jack shall incorporate printed label strip on the dust cap module for identifying the outlet. Printed labels shall be permanent and compliant with ANSI/TIA–606-C standard specifications. **Hand printed labels shall not be accepted.**

C. Faceplates: Standard of quality is Legrand Part # OR-403HDJ14 (4 port) or OR-403HDJ12 (2 port)
   The faceplates shall:
   1. Be of the style as appropriate to fit the modular jack used
   2. Have mounting screws located under recessed designation windows.
   3. Comply with ANSI/TIA 606-C work area labeling standard.
   4. Workstation Outlets: Connector assemblies mounted in faceplate. Provide number of ports as shown on the Drawings.
   5. Retain one of first two subparagraphs below, or retain both as required to match Division 26 Section "Wiring Devices."
   6. Plastic Faceplate: High-impact plastic.
   7. For use with snap-in jacks accommodating any combination of UTP, F/UTP, optical fiber, and coaxial work area cords.

D. Voice / Data Jacks: Standard of quality is Superior Essex Cat 6 for voice/data; Cat 6A for wireless access points

   1. Cat 6 Jacks: 100-ohm, unshielded balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568.2-D up to 250 MHz.
   2. All pair combinations must be considered, with the worst-case measurement being the basis for compliance. Modular jack performance shall be third-party verified by a nationally recognized independent testing laboratory.
   3. The modular jack shall be backwards compatible to Category 3, 5, and 5e.
   4. The modular jack shall be center tuned to category 6 test specifications.

Part Number	Description
OR-HDJ6-36	Legrand Category 6 T568A/B High Density (HD) Jack Blue (Data)
OR-HDJ6	Legrand Category 6 T568A/B High Density (HD) Jack Fog White (Voice)
OR-HDJ6 - xx	xx - Refer to systems plans for breakdown of systems by color.

   5. **Cat 6A jacks (qty 2) to be used for each Wireless Access Points**

(to accommodate for speeds in excess of 1 Gigabit transmission).

6. Jacks: 100-ohm, unshielded balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568.2-D up to 500 MHz.
7. The modular jack shall be backwards compatible to Category 3, 5e and 6.
8. The Wireless Access Point jacks shall be terminated in a 2-port surface mount box.
9. The modular jack shall be center tuned to category 6A test specifications.

Part Number	Description
OR-HDJ6A-43	Legrand Category 6A T568A/B High Density (HD) Jack Orange (Wireless Access Points)

2.3 110 COPPER TERMINATION BLOCK

A. The voice cross connect shall be a passive connection between the horizontal termination blocks and the backbone termination blocks. The wall mount frames shall be field terminated kits including all blocks, connecting blocks, and designation strips.

B. Management rings shall be mounted between vertical columns of blocks to provide management of cross-connect wire.

C. Backbone and horizontal blocks shall use 4-pair connecting blocks. Blocks shall be oriented so that backbone terminations are located on the left and horizontal frames are located on the right of the termination field when facing the frame assembly.

D. Standard of quality: Legrand

E. 110 Block Kits shall:
   1. include both the wiring block in a 50, 100 and 300 pair footprint and the connecting block C6110C5
   2. be manufactured using fire retardant molded plastic.
   3. support termination of 22-24 AWG solid conductor
   4. wiring block shall contain back openings for the feed through of cable
   5. have color-coded tips on the wiring block and color coding on the connector blocks for installation identification.
   6. shall use standard termination practice requiring a single conductor 110 impact tool
   7. have termination hardware that maintains the paired construction of the cable to facilitate minimum untwisting of the wires.
   8. be backwards compatible to category 3, 5 and 5e

F. 110 Cross-Connect System Backboard Channels Shall
   1. be available in 300 and 900 pair sizes.
   2. allow the mounting of 110 100-pair blocks without legs.
   3. include bottom trough and grounding bar.
   4. be wall mountable.
   5. be of cold roll steel construction.

G. 110 Wall Mount Vertical Trough Shall
   1. be available in single channel or dual channel configurations.

2. in dual channel configuration shall be used to provide separation for different wiring media.
3. be available in 300 pair and 900 pair sizes.
4. be wall mountable.
5. be used with wall mountable backboard channels. Acceptable configurations include a 300 pair and a 900 pair.
6. be of cold roll steel construction.

Note: Project may require horizontal analog and backbone cables to be terminated on patch panels in IDF/MDF's. Contact Telecom Representative for details.

2.4 MODULAR PATCH PANELS

A. The Modular Patch Panels shall
1. meet category 6 or 6A component compliance and be verified by a third-party nationally recognized independent testing laboratory
2. be backward compatible to category 3, 5 and 5e
3. be center tuned to category 6 or 6A test specifications
4. Standard of Quality is Legrand

Part Number	Description
OR-PSAHJU48	48 Port unloaded 2RU Panel (for HD Jacks)

2.5 RACKS, CABINETS, AND CABLE MANAGEMENT

The equipment cabinet shall provide vertical cable management and support for the patch cords at the front and back of the rack. Waterfall cable management shall be provided at the top of the rack to maintain proper bend radius and cable support. Wire management shall also be mounted above each patch panel and/or piece of equipment on the rack. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack.

A. Cabinet shall:
1. provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA 568-D.
2. have side access points that allow for access to manage/install distribution cables in the vertical channels.
3. be lockable.
4. contain integrated vertical cable management
5. The standard of quality for wall mount cabinet shall be Legrand:

Part Number	Description
CPI Universal Rack	19" Universal 2-Post Data Rack

6. Acceptable substitutions are Tripp Lite and Middle Atlantic

2.6 HORIZONTAL DISTRIBUTION CABLE

A. All horizontal data station cable and voice cable shall terminate on modular patch panels (copper), or patch/splice cabinets (fiber) in their respective MDF or IDF as specified on the drawings.

B. Category 6 cable will be utilized for standard voice and data drops, and Category 6A cable will be utilized for wireless access points.

C. Copper or fiber cable that offers EPDs (Environmental Product Declaration) and / or HPDs (Health Product Declaration) to apply toward LEED certification are PREFERRED.

1. Products covered by EPDs and HPDs contribute towards one (1) point each in the Material and Resources credit (MRc) category for projects pursuing those credits

2. Products that have both EPDs and HPDs will effectively contribute towards two (2) separate credits in the MR category

D. 100 OHM Category 6 UTP with fire-resistant thermoplastic jacket **with separator or divider** between pairs.

1. Physical Characteristics:
   a. Plenum
      1) Insulation FEP
      2) Jacket: FR, low smoke PVC
      3) Nominal Velocity of Propagation: 73
   b. Non Plenum
      1) Insulation: Polyolefin
      2) Jacket: FR PVC
      3) Nominal Velocity of Propagation: 70
   c. Solid annealed copper conductors
   d. 23 AWG copper conductors
   e. Low-dielectric thermoplastic insulation
   f. Pair-separator for improved performance
   g. Characteristic Impedance: 100 ± 15 Ohms
   h. Comply with UL 444
   i. Comply with NFPA 262
   j. Comply with ICEA S-90-661 for mechanical properties.
   k. Comply with ANSI/TIA-568.2-D for Category 6 UTP cables.
   l. Verified for Category 6 performance by an NRTL
   m. RoHS compliant materials

2. Performance Characteristics:
   a. Guaranteed electrical performance up to 400 MHz
   b. Guaranteed 3 dB margin over ANSI/TIA-568.2-D requirements for NEXT and PSNEXT
   c. Guaranteed 4 dB margin over ANSI/TIA-568.2-D calculated requirements for ACR and PSACR
   d. Printed with unique alpha-numeric code for each package of product
   e. Printed in both feet and meters with the units of length decrementing to indicate the amount of cable remaining in the box.
   f. Tip colors shall be a lighter version of the ring color.
   g. **4 pair UTP for Wireless Access Points for speeds in excess of 1 Gigabit transmission (see section F for 6A specification)**: Cat 6A with isolation wrap (no ground required) or actual shield (needs grounding).

3. Design Make:

a. Standard of quality for Cat 6 is Superior Essex Datagain Cat 6 enhanced UTP.

Plenum Part Number	Description
66-240-2B	Data / Blue / CMP
66-240-4B	Voice / White CMP

Non-Plenum Part Number	Description
66-240-2A	Data / Blue / CMR
66-240-4A	Voice / White CMR

E. 100 OHM Category 6A UTP with fire-resistant thermoplastic jacket with separator or divider between pairs and isolation wrap.

1. Physical Characteristics:
   a. Plenum
      1) Insulation FEP
      2) Jacket: FR, low smoke PVC
      3) Nominal Velocity of Propagation: 73
   b. Non Plenum
      1) Insulation: Polyolefin
      2) Jacket: FR PVC
      3) Nominal Velocity of Propagation: 70
   c. Solid annealed copper conductors
   d. 23 AWG copper conductors
   e. Low-dielectric thermoplastic insulation
   f. Pair-separator for improved performance
   g. Characteristic Impedance: 100 ± 15 Ohms
   h. Comply with UL 444
   i. Comply with NFPA 262
   j. Comply with ICEA S-90-661 for mechanical properties.
   k. Comply with ANSI/TIA-568-C.2 for Category 6A UTP cables.
   l. Verified for Category 6A performance by an NRTL
   m. RoHS compliant materials

2. Performance Characteristics:
   a. Guaranteed electrical performance up to 400 MHz
   b. Guaranteed 3 dB margin over ANSI/TIA-568.2-D requirements for NEXT and PSNEXT
   c. Guaranteed 4 dB margin over ANSI/TIA-568.2-D calculated requirements for ACR and PSACR
   d. Printed with unique alpha-numeric code for each package of product
   e. Printed in both feet and meters with the units of length decrementing to indicate the amount of cable remaining in the box.
   f. Tip colors shall be a lighter version of the ring color.
   g. 4 pair UTP for Wireless Access Points for speeds in excess of 1 Gigabit transmission: Cat 6A with isolation wrap (no ground required) or actual shield (needs grounding).

3. Design Make:
   a. Standard of quality for Cat 6A Superior Essex 10GainXP Plenum (CMP) UTP w/ isolation wrap

2.7 BACKBONE CABLE

1. Backbone cabling shall be provided by the Internet Service Provider of the building.

2.8 FIBER OPTIC TERMINATION HARDWARE

A. FIBER OPTIC ENCLOSURES
1. Fiber optic termination hardware is rack mountable, lockable, and holds various coupler panels based on density requirements.
2. Fusion Splicing (splice cassettes, pigtails, or splice on connectors) shall be the preferred termination style for any new installations, unless otherwise stated.
3. Internal lighting for ease of use
4. Pivot arms for fiber slack management
5. Standard of quality is Legrand
6. Acceptable Substitutions are Commscope and Corning
7. Fiber Enclosures

Part Number	Description
OR-INFC01U-M4	1U combo splice/patch enclosure, holds 4 adapter panels,
OR-INFC02U-M4	2U combo splice/patch enclosure, holds 8 adapter panels,
OR-INFC04U-M4	4U combo splice/patch enclosure, holds 16 adapter panels,

B. Splice cassettes (used instead of standard fiber optic adaptor panels)

Part Number	Description
OR-M4LCD12-50ES2A1	Fusion Splice Cassette 50um Multimode 12 fiber LC
OR-M4LCD12-09S1A1	Fusion Splice Cassette Singlemode 12 fiber LC

Fan Out Kits (if needed to build up 250um fiber before termination)

Part Number	Description
OR-61500858	Breakout Kit 12 fiber

C. FIBER OPTIC ADAPTER PANELS (used w/ pigtail or splice on connector terminations)

Legrand Adapter panels will be of 6 duplex LC connectors (12 fibers) for both multimode and single mode connections.

Part Number	Description
OR-HDFP-LCD12LC	6-LC Duplex multimode, aqua adapters, ceramic sleeve 12 fiber
OR-HDFP-LCD12AC	6-LC Duplex Single mode, blue adapters, ceramic sleeve 12 Fiber
OR-HDFP-BLANK	Blank Filler modules

D. FIBER OPTIC PIGTAILS / CONNECTORS

1. For fiber **splicing**, utilize Legrand 12 strand LC fiber pigtails or fusion splice on connectors. Legrand part numbers:

2. When **mechanical** terminations are acceptable for MAC work, Utilize Legrand LC single mode (OR-205KNT9SA-09) and multimode (OR-205KNT9GA-50T) Infinium Connectors for standard terminations.

Part Number	Description
OR-P1TC4ZRSZZZ001M	12 strand Single mode LC fusion splice pigtail
OR-P1TF4ZRGZZZ001M	12 strand Multimode LC fusion splice pigtail
OR-205KNF9SA-09	Single mode fusion splice on connector,
OR-205KNF9FA-50T	Multi Mode fusion splice on connector
OR-205KNT9SA-09	LC Single mode Infinium mechanical connectors
OR-205KNT9GA-50T	LC Multimode Infinium mechanical connectors

3. Acceptable Substitutions are Systimax and Corning

2.9 PATCH CORDS & FIBER JUMPERS

A. The contractor shall provide factory terminated and tested UTP and optical fiber patch cords and equipment cords for the complete cabling system. The UTP patch cables shall meet the requirements of ANSI/TIA 568-D for patch cord testing.

B. Copper (UTP) patch cords shall:

1. Standard of quality is Legrand **Cat 6**; OR-MC6-zz-xx (zz=length; xx = color) and **Cat6A** for WAPs; OR-MC6A-zz-xx
2. Standard lengths include, 3 ft, 5 ft, 7 ft, 9 ft, 10 ft, 15 ft.
3. use 8 position connector with impedance matched contacts and designed using dual reactance.
4. be constructed of 100 ohm, 4 pair, 24 AWG, stranded conductor, unshielded twisted pair copper per the requirements of the ANSI/TIA 568.2-D.
5. meet TIA category 6 component specifications in ANSI/TIA 568.2-D
6. 100% factory tested to meet category 6 performance and
7. ETL or any other nationally recognized 3rd party verification
8. be capable of universal T568A or T568B wiring schemes.
9. Modular connector shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires.
10. have “snagless” protection for the locking tab to prevent snagging and to protect locking tab in tight locations and provide bend relief
11. be backwards compatible to Category 3, 5 and 5e
12. be manufactured by an ISO 9001 registered company.
13. Provide one 10 foot Cat6A patch cord for every switch port.
14. Provide one 7 foot Cat6A patch cord for every workstation phone and computer.
15. Provide one 3 foot Cat6A patch cord for every wireless access point
16. The contractor shall include the labor cost in the quote to install all patch cords in the wiring closets as well as the workstation and wireless access points.
17. **Cat 6A copper patch cords for Wireless Access Points** for speeds in excess of 1 Gigabit transmission: Cat 6A Standard of Quality is Superior Essex

C. Fiber jumper cords shall:

1. Standard of quality for Multimode duplex 5 meter 50 um 10 gig aqua for multimode applications is Legrand LC to LC (OR-P1DF2LRGZGZ005M).
2. Provide four (4) duplex LC-LC 5 meter jumpers per switch in each TR.
3. Standard of quality for Single Mode duplex 5 meter for single mode applications is Legrand LC to LC (OR-P1DC2IRSZSZ005M).
4. Provide two (2) duplex LC-LC 5 meter jumpers per rack in each TR.
5. Acceptable substitutions are Quiktron, Systimax and Corning

2.10 PATHWAYS & PENETRATIONS

A. Conduit

1. All conduit work shall meet the requirements of the National Electrical Code.
2. All voice, data and video wiring inside rooms shall be protected by metallic conduit or other means such as Legrand/Wiremold or troughs in the floor. Aluminum is not acceptable in caustic environments. EMT conduit shall be used for all interior wiring. All conduits are to be concealed.
3. No more than an equivalent of two 90-degree bends are allowed in a run between junction boxes or pull boxes.
4. Entrance to junction boxes or distribution panels shall be adjacent to the corners.
5. In major renovation and new construction projects where the MDF/IDF are not in alignment, the contract shall include provisions for installation of four riser conduits (4 inches minimum diameter) from the MDF to each IDF. A pull string and appropriate junction pull box shall also be provided in each conduit run to facilitate future installation of cable(s). Maxcell fabric innerduct should be used to create multiple pathways in each 4" conduit.
6. All conduits in slab shall be a minimum of 1 inch. All exceptions shall be determined during the design stage of the project and shall be subject to the approval of the engineer.
7. All sleeves must protrude 4 inches AFF and below and be capped at both ends. Coordinate with customer for the number of conduits entering the facility. All sleeves must be bonded to the telecommunications bonding system.
8. No horizontal conduit run shall be more than 100 feet between pull boxes.
9. Pull boxes must be installed every 180 degrees or 100 feet of the conduit run. All conduit stubs must be bonded to the telecommunications grounding system.

B. Conduit/Raceway Capacity

1. Conduit shall be sized using industry standard guidelines for telecommunications distribution methods. Guidelines can be found in the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual and/or cabling manufacturers' guidelines. Utilize Maxcell fabric innerduct to maximize conduit fills

Part Number / Series	Description
MXC4003 series	Standard 4" 3 Cell fabric innerduct
MXP4003 series	Plenum 4" 3 Cell fabric innerduct
MXR4003 series	Riser 4" 3 Cell fabric innerduct
MXD4003 series	Detectable 4" 3 Cell fabric innerduct
MXC3456 series	Standard 3" 3 Cell fabric innerduct
MXP3456 series	Plenum 3" 3 Cell fabric innerduct
MXR3456 series	Riser 3" 3 Cell fabric innerduct

MXD3456 series	Detectable 3" 3 Cell fabric innerduct

C. Cable Trays

1. Standard of quality for basket tray is **Cablofil.**

2. All cable trays shall be designed to accommodate all types of cabling. Note that installation shall be in non-return air plenum space only. All telecommunications pathways (Caddy J-hooks, basket tray or Legrand/Wiremold raceways) shall be used for communications medium (voice, data and fiber optic cabling) only.

3. The minimum dimensions for a cable tray shall be 12 inches wide and 4 inches deep. The tray must consist of continuous, rigid, welded steel or stainless steel wire mesh cable management system. The cable tray systems are defined to include, but are not limited to, straight sections, supports and accessories. Wire mesh cable tray will have continuous Safe-T-Edge T-welded top side wire to protect cable insulation and installers. Basket tray shall be spliced using EDRNs on the sides as well as an SWK washer/nut in the bottom of the tray.

4. Contract documents shall show cross section of the communication wire way or cable tray. The drawing must show reference to other utilities in the building. All sections of the cable tray must be bonded together with approved bonding methods and devices. For installation of other types of "approved" low voltage cables in the cable tray, a separate tray or at minimum a divider in the basket tray to prevent interference from unshielded cables is required.

5. Supports for cable trays larger than 12 inches in width are to be installed according to the manufacturer specifications. A single support is not acceptable. All supports are to be fastened to the building structure above. If the cable tray will be of a wall mount type, it must be installed properly to provide proper permanent support at trays maximum capacity.

6. Radius Drop outs shall be used whenever multiple cables are exiting the tray.

7. STI's EZ Path's (44, 33 or 22 series) shall be used in conjunction with the tray whenever cabling is going through a fire rated wall.

8. Cable trays must maintain a minimum of 6-inch clearance from obstructions above the tray and a minimum of 8 feet AFF. Trays are to provide access via the most direct path to all communications outlets on the floor.

9. Install sweeping factory 90's for all turns. Use end-of tray terminations where wire drops down to walls to prevent abrasions and cuts from metal tray edges. Use a trapeze supported cable tray mounting method suspended by manufacturer recommended size all-thread. Fasten all-thread to ceiling anchors, allowing no bends in all-thread. Support the cable tray in this manner at every section-to-section junction and at 5 feet to 6 feet intervals (mid span) between joints. Whenever possible, the tray should be no closer than 6 inches from the structural ceiling, ducts or pipes, considering all other possible obstructions. A minimum of 5 inches distance from lighting, especially fluorescent lighting, is desired.

10. Coordinate layout and installation of cable tray with other trades. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect. Basket tray installation in the TRs shall be installed as depicted on the drawings by the Telecommunications Contractor. The basket tray

that is to be installed for the horizontal and backbone distribution will be provided and installed by the electrical contractor.

11. Storage and Handling: Avoid breakage, denting and scoring finishes. Damaged products will not be installed. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage.

12. Refer to the drawings for the size and location of the tray to be installed.

13. Ground cable trays at end of continuous run. Ground continuous cable tray runs every 60 feet. Cable trays that are not UL Classified will be grounded per NEC requirements and manufacturer recommendations.

14. Ground cable trays against fault current, noise, lightning, and electromagnetic interference by mounting grounding wire to each 10' cable tray section with grounding clamp.

D. Open Top Cable Supports (J-hooks)

1. Standard of quality is Erico/**Caddy HP** series of j-hook
2. All open top cable supports (J-hooks) must be suspended from or attached to the structural ceiling or walls with hardware or other installation aids from Caddy specifically designed to support their weight. When used, Caddy J hooks shall be located on 48 to 60 inch centers to adequately support and distribute the cables weight. These types of supports may typically hold up to fifty 0.25-inch diameter cables.
3. No other cables shall be run in the same j-hooks along with the voice and data cables. A separate painted (white, red, blue, green) Caddy j-hook system must be provided to facilitate the installation of other low voltage cabling.
4. For larger quantities of cables that convene at the Telecommunications Closet, provide Cablofil cable trays or other special ERICO/CADDY supports that are specifically designed to support the required cable weight and volume.
5. No plastic j-hooks will be allowed.
6. Substituted material must demonstrate product equivalency.

E. Floor Mounted Assemblies (Floor Boxes and Poke Throughs)

1. All Floor Mounted Assemblies including floor boxes, poke through, floor outlets, floor mounted whips, tombstones, etc. shall be sized using industry standard guidelines for telecommunications distribution methods; specifically relating to cable fill ratios and limitations. Guidelines can be found in the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual and/or through individual cabling manufacturers' installation guidelines.

2. Standard of quality for all Poke-throughs and floor boxes is the Evolution series from Legrand/Wiremold.

3. Floor boxes Shall:

   a. be used in concrete, raised floor and wood floor applications and are fully adjustable both pre and post concrete pour.
   b. have removable dividers and a tunnel feature that allows all compartments to be connected.
   c. have removable modules through the top or back of the floor box.

d. The floor box hinge must is able to open to a full 180º and lie flat on the floor surface providing easy access to interior modules. Cable egress doors lock in position when open and will automatically close around wires to protect cabling and avoid tripping hazards.
e. accept single, double or triple wall plates as well as accommodate power, communications and A/V devices.
f. be designed to maintain up to a 2 hour fire rating.

F. Wall Boxes (A/V, Power, Data behind flat screens)

1. Standard of quality for all wall boxes is the Evolution series from Legrand/Wiremold.
2. Wall Boxes Shall:
   a. be used for TVs, Monitors, & Digital Signage for use in new construction and renovation construction projects.
   b. be compatible with complete line of workstation connectivity outlets and modular inserts, and most audio/video manufacturers' products.
   c. provide the interface between power, communication and audio/video (A/V) cabling new construction and renovation location where power and communication and/or A/V device outlets are required.
   d. provide recessed device outlets that will not obstruct the wall area.
   e. permit all wiring to be completed at box level

G. Conference/Collaboration/Training Room Solutions (Table Boxes; Cable Retractors, Under-table cable management)

1. Standard of quality is Wiremold/Legrand Integreat series

2. **Table Boxes / Table penetrations**:
   a. Cover: Brushed, anodized aluminum cover in a black or aluminum finish with beveled edges and "soft-touch" handle.
      1) Cover contains a "pocket" door which fully recesses into the box when open, giving access to connections without obstructing work surface. A finishing plate hides hardware on activation surface and permits labeling of the AVIP plates.
      2) Cover flange allows for 1/4-inch [6.4mm] of forgiveness in the cut out opening.
   b. Activation Surface: Adjustable downward in 1/2-inch [12.7mm] increments, from one (1) inch to four (4) inches [25mm to 102mm] to allow cover to close even when large style connectors are used.
   c. Provide table boxes with a 12 foot SJT cord for easy connection to electrical infrastructure.
   d. Supply tables boxes with a cable grommet kit that can accommodate up to eight (8) pull out connections. Boxes shall also be capable of accepting up to five (5) Wiremold AVIP connectors.
   e. Provide table boxes with two (2) 15 amp receptacles in top compartment and one (1) 15 amp receptacle on underside of box.

3. **Cable Retractors**: InteGreat™ Series cable retractors; mounts directly to InteGreat™ Series A/V Table Box or underside of conference room table using a horizontal mounting bracket.
   a. Cable Retractors with Category 6 Cable: Catalog No. TBCRCAT6A; loaded with 12 feet [3.66m] of Cat6A cable that extends out five (5) feet [1.52m] from retractor. Supply retractor with a female input from building infrastructure and a male connector on the output side.

b. Cable Retractors with VGA Cable: Catalog No. TBCRVGA; loaded with 12 feet [3.66m] of VGA cable that extends out five (5) feet [1.52m] from retractor. Supply retractor with a female input from building infrastructure and a male connector on the output side.
c. Cable Retractors with HDMI Cable: Catalog No. TBCRHDMI; loaded with 12 feet [3.66m] of HDMI cable that extends out five (5) feet [1.52m] from retractor. Supply retractor with a female input from building infrastructure and a male connector on the output side. Provide input side with mounting tab that allows installer to cable tie HDMI to retractor to minimize chances of loose connections.
d. Cable Retractors with 3.5MM Audio Cable: Catalog No. TBCR3.5MM; loaded with 12 feet [3.66m] of audio cable that extends out five (5) feet [1.52m] from retractor. Supply retractor with a female input from building infrastructure and a male connector on the output side.
e. Cable Retractor Horizontal Mounting Brackets: Catalog No. TBCRHMK; permits retractor to mount horizontally under conference room table, enabling cable access through a table grommet. Multiple retractors can be mounted to each other by attaching the mounting brackets to each other.

4. **Under Table Cable Management Kit**: InteGreat™ Series under table cable management kit provides clean cable management for power, communication and A/V cables on horizontal underside of table.
   a. Under Table Cable Management Kit: Catalog No. UTCM5; includes five (5) feet [1.524mm] length of divided base, five (5) feet [1.524mm] length of mounting hinge rail and four (4) latching clips; black, nonmetallic construction.
   b. Transition Channels: InteGreat™ Series transition channels continue cable management and protection from underside of the table to the floor, where cables can gain access to building infrastructure. Channel fits directly into under table cable management kit on underside of table and mates with poke-thru device or over floor raceway for smooth transition to building infrastructure.
   c. Transition Channels: Catalog No. MRTC; consists of aluminum center spline with steel mounting plate and four (4) screws, black aluminum side channels, black nonmetallic bottom boot and two (2) black nonmetallic transition covers.

Part Number / Series	Description
EFB Series	Evolution Floor Box
6AT Series	Evolution Poke Throughs 6”
8AT Series	Evolution Poke Throughs 8”
EFSB2 Series	Evolution 2 Gang Wall Box
EFSB4 Series	Evolution 4 Gang Wall Box
TB Series	Integreat A/V Table Box
TBCRCAT6A	InteGreat Cable Retractor Cat 6A
TBCRVGA	InteGreat Cable Retractor VGA
TBCRHDMI	InteGreat Cable Retractor HDMI
UTCM5	InteGreat Under Table Cable Mgmt.
MRTC	InteGreat Transition Channel

5. Substituted materials for floor boxes, poke throughs, wall boxes and conference room applications must be able to demonstrate product equivalency.

2.11 AUDIO/VISUAL INFRASTRUCTURE

For applications involving patient rooms, classrooms, conference rooms, collaborative work spaces, etc., that require HDMI, USB, Display Port, VGA, and other digital and/or analog A/V connections, the cabling infrastructure shall utilize Quiktron as the standard of quality. Substituted materials for all A/V applications must be able to demonstrate product equivalency.

A. HDMI-to-HDMI, HDMI-to-DVI, DVI-to-HDMI and DVI-to-DVI

1. Direct (native signal) connections (point-to-point) shall be HDMI High Speed Rated and designed and tested to handle video resolutions of 1920 x 1080p or greater, including advanced display technologies such as 4K, UltraHD, 3D, and Deep Color
2. Direct (native signal) connections (point-to-point) shall not exceed 20 meters in total combined length and may be CMP, CMR, CM, CL3 or CL2 rated as appropriate to the installation and applicable code
1. Connections less than 20 meters in total combined length shall be a certified copper cable or connectivity solution, except when:
   a. Direct (native signal) connections (point-to-point) that require a form factor different than that typically available in a quality copper assembly may leverage the selection of "media conversion" and other solutions offered for such situations, and will include as acceptable alternatives RapidRun™, RapidRun Optical™ HDMI-over-Coax, HDBaseT, HDMI-over-UTP.
2. Connections greater than 20 meters in total combined length shall be certified connectivity solutions, as best serves the form factor needed, from the selection defined below:
   a. RapidRun Optical™
   b. HDMI-over-UTP, HDMI w/ serial RS232-over-UTP, HDMI w/ VGA-over-UTP, HDMI w/ VGA and Stereo Audio-over-UTP, HDMI w/ VGA, Audio, and Composite Video-over-UTP or HDMI-over-Coax
3. In installations where it is determined that insufficient bus power (Vbus) exists for reliable performance, the Quiktron HDMI Power Inserter may be used

B. Universal Serial Bus (USB)

1. USB connections (point-to-point) less than 5 meters total length shall be Quiktron USB 2.0 rated for all applications
   a. Systems specifically requiring USB 3.0 or faster speed transfer ability (SuperSpeed or SuperSpeed Plus) may include Quiktron USB 3.0 cables, which may not exceed 3 meters total combined length
2. USB connections (point-to-point) more than 5 meters in total length shall be Quiktron connectivity solutions, as best serves the form factor needed for installation, from the selection defined below:
   a. USB connections greater than 5 meters but less than 12 meters in length shall be Quiktron USB Active Extender Cable solutions, or
   b. USB connections greater than 5 meters but less than 100 meters in length shall be Quiktron USB 1.1 over Cat 5 SuperBooster or Quiktron USB 2.0 over Cat 5 SuperBooster solutions as required by the system design
3. USB external hubs shall be Quiktron USB 3.0 SuperSpeed rated with dedicated power supply (powered hubs)
   a. No more than four (4) tiers of USB connectivity shall be allowed without inclusion of a powered hub to restore full USB bus (V_{bus}) power for proper operation of downstream devices and links

C. DisplayPort

1. DisplayPort cables shall be Quiktron DisplayPort rated 1.1 performance or greater, and
2. DisplayPort point-to-point direct connections shall not be more than 10 meters in total combined length
3. DisplayPort point-to-point direct connections greater than 10 meters in total combined length shall be transported via DisplayPort-to-HDMI conversion (dongle) and shall then use an HDMI connection solution approved for connections of HDMI signals beyond 20 meters as detailed above (see HDMI), or
4. DisplayPort point-to-point direct connections greater than 10 meters in length shall be transported via RapidRun Optical

D. D-sub 15, mini sub D15, mini D15, DB-15, HDB-15, HD-15 or HD15, hereafter collectively called VGA

1. VGA direct (native signal) connections (point-to-point) shall be designed and tested to support video resolutions of up to QXGA (2048x1536) and pass Extended Display Identification Data (EDID) signals
2. VGA direct (native signal) connections (point-to-point) shall not exceed 50 meters in total combined length without appropriate signal conditioning and may be CMP, CMR, CM, CL3 or CL2 rated as appropriate to the installation and applicable code
3. VGA direct (native signal) connections (point-to-point) shall be certified connectivity solutions, as best serves the form factor needed, from the selection defined below:
   a. RapidRun™
   b. RapidRun Optical ™
   c. Select or Select w/audio
   d. Premium Shielded or Premium Shielded w/audio

2.12 COPPER CABLE PROTECTION UNITS

A. All copper circuits shall be provided with protection between each building with an entrance cable protector panel. All building-to-building circuits shall be routed through this protector. The protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TC ground point.

B. Standard of quality of protection units is Circa.

C. The two most frequently used lightning protectors are listed below.

D. Circa Protector -- “Circa”, part number 1900A1-100, and Circa 3B3S-300 “Red” modules -100 for 100 pair.

E. Use Circa ,part number 1880ENA1/NSC-6 for single drops of 6-pair or less. Use Circa, part number 3B1E gas protector modules.

Part Number / Series	Description
1890BC1-25	25 Pair Protector
1890BC1-50	50 Pair Protector
1900A1-100K	100 Pair Protector
3B1E	Solid State Protector Module for 189B1

2626QC/QC	Protection Block (66 connection must add gas modules 3B1E (black) or 3B3E (red))
4B1E	Gas state Protector 5 Pin Black with Heat Coil
4B3S-75	Protector Module 5 Pin Red Solid state with Heat Coil
3B3S-300	Protector module 5 Pin Red Solid state w/o Heat coil
4B1S-300	Protector Module 5 Pin Black Solid state with Heat Coil
1880ENA1/NSC-6	6 Pair Protector

2.13 FIRESTOP

A. Standard of quality is EZ Path Fire rated cable pathway devices shall be used in fire-rated construction for ALL low-voltage, video, data and voice cabling, optical fiber raceways and certain high-voltage cabling where frequent cable moves, adds and changes may occur. Pathways required for high voltage cabling will be detailed on the prints. Such devices shall:

1. Meet the hourly fire-rating of fire rated wall and or floor penetrated.
2. Be tested for the surrounding construction and cable types involved.
3. Have UL Systems permitting cable loads from; "Zero to 100% Visual Fill." This requirement eliminates need for fill-ratio calculations to be made by cable technicians to ensure cable load is within maximum allowed by UL System.
4. Not have inner fabric liner that tightens around and compresses cables tightly together encouraging potential cable damage or interference.
5. Be "Zero-Maintenance", zero-maintenance is defined as; No action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
    a. Opening or closing of doors.
    b. Spinning rings to open or close fabric liner.
    c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
    d. Furnish letter from manufacturer certifying compliance with this definition of "Zero-Maintenance".
6. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
7. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
8. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.
9. Cable pathway shall replace conduit sleeves in walls and floors, and;
10. When installed individually in floors, devices shall pass through core-drilled opening utilizing tested floor plates.
11. When installed individually in floors, devices shall pass through core-drilled opening utilizing tested floor plates.
12. When multiple units are ganged in floors, devices shall be anchored by means of a tested grid.

13. When installed individually in walls, devices shall pass through core drilled opening utilizing tested wall plates or integrated flanges.
14. When multiple units are ganged in walls, devices shall be anchored by means of a tested grid.
15. Cable tray shall terminate at each barrier (wall) and resume on the other side such that cables pass independently through devices. Cable tray shall be properly supported on each side of the barrier (wall). Cable tray shall NOT pass through the barrier (wall).
16. Substituted material must demonstrate product equivalency.

B. As an alternate to using a fire-rated or non-rated cable pathway device for single low voltage cables (up to 0.27 in. (7 mm) O.D) penetrating one or two-hour, gypsum board/stud wall assemblies or non-rated assemblies, either as a through-penetration or as a membrane-penetration, a fire-rated EZ Path individual cable grommet may be substituted. The product shall consist of a molded, two-piece, plenum-rated grommet having a foam fire and smoke sealing membrane that conforms to the outside diameter of the individual cable. The grommet product shall be capable of locking into place to secure the cable penetration within the wall assembly. The grommet shall be UL Classified and tested to the requirements of ASTM E814 (UL1479) and CAN/ULC S115.

17. Acceptable Products from STI:

Part Number / Series	Description
EZD22	2” EZ Path Firestop Device
EZD33FWS	3” EZ Path Firestop Device
EZDP133CWK	3” EZ Path Firestop Device Kit (for 4” conduit)
EZDP33FWS	3” EZ Path Firestop Device Kit (square mount)
EZP433W	3” Ganging Accessory (Qty 4) for 3” EZ Paths
EZD44S	6” EZ Path Firestop Device
EZDP44S	6” EZ Path Firestop Device Kit (square or round mount)
EZP544W	Ganging Accessory (Qty1-5) for 6” EZ Paths
EZGxxxxx	Grid for riser applications
RFG2	Individual Cable EZ firestop grommet (10 pack)

2.14 GROUNDING AND BONDING

A. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building’s electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA-607 Telecommunications Bonding and Grounding Standard.

B. The main entrance facility/equipment room in each building shall be equipped with a PBB (Primary Bonding Busbar) formerly known as the telecommunications main grounding bus bar (TMGB). Each telecommunications room shall be provided with a SBB (Secondary Bonding Busbar formerly known as the telecommunications ground bus bar (TGB). The PBB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.

C. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the TR or ER shall be grounded to the respective SBB or PBB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.

D. All wires used for telecommunications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and bus bars shall be identified and labeled in accordance with the System Documentation Section of this specification.

E. Standard of quality for all grounding and bonding products shall be Legrand.

F. Acceptable substitutions are Erico and Panduit

PART 3 - EXECUTION

3.1 WORK AREA OUTLETS

A. Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. In hollow wall installations where Caddy box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

B. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA 568.1-D document, manufacturer's recommendations and best industry practices.

C. Pair untwist at the termination shall not exceed 12 mm (one-half inch).

D. Bend radius of the twisted-pair horizontal cable shall not be less than 4 times the outside diameter of the cable.

E. The cable jacket shall be maintained to within 25mm (one inch) of the termination point.

F. Data jacks, unless otherwise noted in drawings, shall be located in the bottom position(s) of each faceplate. Data jacks in horizontally oriented faceplates shall occupy the right-most position(s).

G. Voice jacks shall occupy the top position(s) on the faceplate. Voice jacks in horizontally oriented faceplates shall occupy the left-most position(s).

3.2 HORIZONTAL DISTRIBUTION CABLE INSTALLATION

A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.

B. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

C. Cable raceways shall not be filled greater than the ANSI/TIA 569-D maximum fill for the particular raceway type or 40%.

D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.

E. Where transition points, or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.

F. The cable's minimum bend radius and maximum pulling tension shall not be exceeded.

G. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

H. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

I. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

J. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.

K. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.

L. Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification and ANSI/TIA 606-C. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.

M. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.

N. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.

3.3 HORIZONTAL CROSS CONNECT INSTALLATION

A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA 568-D standard, manufacturer's recommendations and best industry practices.

B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).

C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

E. The cable jacket shall be maintained as close as possible to the termination point.

F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.4 OPTICAL FIBER TERMINATION HARDWARE

A. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

C. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.

D. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.

E. A maximum of 12 strands of fiber shall be spliced in each tray

F. All spare strands shall be installed into spare splice trays.

3.5 BACKBONE CABLE INSTALLATION

A. Backbone cables shall be installed separately from horizontal distribution cables

B. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

C. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits

D. Where backbone cables are installed in an air return plenum, riser rated cable shall be installed in metallic conduit.

E. Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

F. All backbone cables shall be securely fastened to the sidewall of the TR on each floor.

G. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.

H. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.

I. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

3.6 COPPER TERMINATION HARDWARE

A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568-D standard, manufacturer's recommendations and best industry practice.

B. Pair untwist at the termination shall not exceed 12 mm (one-half inch).

C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

E. The cable jacket shall be maintained to within 25 mm (one inch) of the termination point.

F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.7 RACKS

A. Racks shall be securely attached to the concrete floor using a minimum 3/8" hardware or as required by local codes.

B. Racks shall be placed with a minimum of 36 inch clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.

C. All racks shall be grounded to the telecommunications ground bus bar in accordance with Section 2.11 of this document.

D. Rack mount screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.

E. Wall mounted termination block fields shall be mounted on 4' x 8' x .75" void free plywood. The plywood shall be mounted vertically 12" above the finished floor. The plywood shall be painted with two coats of white fire retardant paint.

F. Wall mounted termination block fields shall be installed with the lowest edge of the mounting frame 18" from the finished floor.

3.8 FIRESTOP SYSTEM

A. All firestop systems shall be installed in accordance with the manufacturer recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.

3.9 GROUNDING SYSTEM

A. The TBB shall be designed and/or approved by a qualified PE, licensed in the state that the work is to be performed. The TBB shall adhere to the recommendations of the ANSI/TIA 607-C standard, and shall be installed in accordance with best industry practice.

B. Installation and termination of the main bonding conductor to the building service entrance ground shall be performed by a licensed electrical contractor.

3.10 IDENTIFICATION AND LABELING

A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. Labeling shall follow the guidelines of ANSI/TIA-606-C.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and

destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA-606-C. Furnish electronic record of all drawings, in software and format selected by Owner.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

4. Both ends of all backbone cable shall be labeled. Labels will be self laminating and machine generated. The label shall contain the following information:
    a. The Origination (TR it is feeding from).
    b. The Destination (TR it is feeding).
    c. Number of pairs or fibers

5. Both ends of all horizontal cables shall be labeled. Labels shall be self-laminating and machine generated. The cable, workstation faceplate, panel ports and block positions shall be labeled with the room number, location in room, outlet type & # (data D1, D2, etc). In rooms with multiple outlets, label clockwise as you enter the room: 1, 2, 3 e.g. a data port at the first drop location to the left of Room 216 door would be (216-1 D1). When terminating workstation cables in the TR, organize and label the cables in numeric room number order at the patch panel.

6. CNS will approve all labeling schematics prior to installation. "As-Built" drawing with all outlets identified shall be provided.

F. Labels shall be self-laminating or computer-printed type with printing area and font color that contrasts with cable jacket color. Handwritten labels will not be acceptable.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

2. All labeling methodology, identification logic, and materials will be approved by customer prior to installation.

3. If existing labeling scheme is in place, all labeling will defer to currant scheme as to stay consistent with facility.

3.11 TESTING AND ACCEPTANCE

A. General

1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA 568D; marginal passes (*PASS) are not acceptable. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

2. All cables shall be tested in accordance with this document, the ANSI/TIA standards, the Legrand Certification Program Information Manual and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.

B. Copper Channel Testing

1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance.

2. Horizontal cabling shall be tested using a Level III test unit for category 6 performance compliance.

3. The basic tests required are:

    a. Wire Map
    b. Length
    c. Attenuation
    d. NEXT (Near end crosstalk)
    e. Return Loss
    f. ELFEXT Loss
    g. Propagation Delay
    h. Delay skew
    i. PSNEXT (Power sum near-end crosstalk loss)
    j. PSELFEXT (Power sum equal level far-end crosstalk loss)

4. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

5. Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA 568-D Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.

6. Category 6 Performance

   Shall meet the channel requirements outlined below for a 100-meter, 4-connector channel.

   Channel Margin Guarantees

Parameter	Margin vs. TIA-568-C.2
Insertion Loss	3%
NEXT	5 dB
PSNEXT	5 dB
Return Loss	3 dB
ACRF	5 dB
PSACRF	5 dB
ACR	5 dB
PSACR	5 dB

C. Fiber Testing

1. Testing procedures shall be in accordance with the following:
   a. ANSI/TIA 568-D
   b. ANSI/TIA 568.1-D
   c. ANSI/TIA 526-7-A, Method A.1
   d. ANSI/TIA 526-14-C, Method B
   e. TSB-140 Tier 1 fiber testing is required. Tier 2 Fiber Testing is recommended
   f. ANSI-TIA-1152-A determines the copper field test instrument values.
2. Preparation
   a. Properly clean all connectors, adapters, and jumpers prior to testing.
   b. Insure that the testing jumpers are of the same fiber core diameter and connector type as the fibers to be tested.
   c. The power meter shall be properly calibrated prior to testing. Contractor to provide written confirmation of the calibration, with the power meter serial number, to the Owner, if requested. If this documentation is not available upon request, the Contractor shall re-test all optical fiber cables after documented calibration of the power meter is accomplished.
3. Test Equipment
   a. Optical power meter and source (Certification tester Fluke or Agilent preferred). Suitable OTDR with launch cable for Tier 2 testing. OTDR Launch Cable length recommendation is 75 meters for MMF and 300 meters for SMF systems.
4. Testing
   a. All Multimode fibers shall be tested to the requirements of ANSI/ TIA-568-D, TIA-525-14A (Method A.1) and TSB-140. Optical fibers shall be tested at both 850 nm and 1300 nm wavelengths for end-to-end insertion loss .and Bi –Directional (MTR to TR-1, TR-1 to MTR)

b. All Single-mode fibers shall be tested to the requirements of ANSI/ TIA-568-D, TIA-526-7 (or Method A.1) and TSB-140. Optical fibers shall be tested at both 1310 nm and 1550 nm wavelengths for end-to-end insertion loss and Bi-Directional (MTR to TR-1, TR-1 to MTR)
c. Insure that the power meter and light source are set to the same wavelength prior to testing each fiber.
d. Connect an appropriate test jumper to the light source and power meter.
e. Power on both the power source and light meter, allowing them to stabilize.
f. Record the reference power reading in dB. If the jumper is removed from the light source for any reason, the reference power reading must be re-established.
g. Insert a second appropriate jumper, using an appropriate adapter, between the first jumper and the power meter. Record the power reading in dB.
h. Reference TSB-140 for additional recommendations and testing guidelines.
i. Provide written documentation of all test results to owner. Provide electronic copy of test results, in original tester format, to manufacturer when registering project for warranty on-line.

3.12 SYSTEM DOCUMENTATION

A. Upon completion of the installation, the telecommunications contractor shall provide three (3) full documentation sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.

B. Documentation shall be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test result and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. At the request of the Engineer, the telecommunications contractor shall provide copies of the original test results.

C. The Engineer may request that a 10% random field re-test 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 telecommunications contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

3.13 TEST RESULTS

A. Test documentation shall be provided on disk within three weeks after the completion of the project. The disk shall be clearly marked on the outside front cover with the words “Project Test Documentation”, the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific

settings of the equipment during the test as well as the software version being used in the field test equipment.

B. The field test equipment shall meet the requirements of ANSI/TIA 568-C including applicable TSB's and amendments. The appropriate Level III tester shall be used to verify Category 6 cabling systems.

C. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. The telecommunications contractor must furnish this information in electronic form (format to be determined by the end user).

D. Test documentation shall also be provided to the manufacturer within three weeks after the completion of the project. Test results shall be uploaded when registering the project for warranty using the manufacturer's on-line system. Test results shall be in the tester's original format from an approved tester listed on manufacturer's website. All test results must show a PASS; marginal passes (*PASS) are not accepted.

E. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

3.14 AS-BUILT DRAWINGS

A. 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. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD rel. 14) formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.

B. The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (AutoCAD rel. 14) form.

PART 4 - WARRANTY AND SERVICES

4.1 WARRANTY

A. A warranty shall be provided for all internal infrastructure wiring as it pertains to voice and data networking for both copper and fiber systems. All installations must be performed according to the manufacturer's System Warranty and Performance Application.

B. The warranty will combine an extended product and applications assurance warranty for a minimum of 25 years.

C. An Extended Product Warranty shall be provided which warrants functionality of all components used in the system from the date of registration. The Extended Product Warranty shall warrant the installed horizontal and/or backbone copper, and both the horizontal and the backbone optical fiber portions of the cabling system.

D. The Application Assurance Warranty shall cover the failure of the wiring system to support the applications that are designed for the link/channel specifications of ANSI/TIA-568.1-D. These applications include, but are not limited to, 10BASE-T, 100BASE-T, 1000BASE-T, and 155 Mb/s ATM.

E. The contractor shall provide a warranty on the physical installation.

4.2 CONTINUING MAINTENANCE

A. The contractor shall furnish an hourly rate with the proposal submittal, which shall be valid for a period of one year from the date of acceptance. This rate will be used when cabling support is required to affect moves, adds, and changes to the system (MACs). MACs shall be performed by a certified Contractor and shall be added to the warranty when registered with manufacturer.

4.3 FINAL ACCEPTANCE & SYSTEM CERTIFICATION

A. Completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a two week period will constitute acceptance of the system. Upon successful completion of the installation and subsequent inspection, the end user shall be provided with a certificate, from the manufacturer, registering the installation.

END OF SECTION

SECTION 28 13 00

ACCESS CONTROL SYSTEMS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

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

1.1 SUMMARY

A. Section includes:

1. Access control
2. Stranded power and control cable
3. Cable connecting hardware, patch panels, and cross connects.
4. Cable management system
5. Cabling identification products
6. Grounding
7. Pathways.
8. Project Warranty and Equipment Manufacturer Warranty
9. Fireproofing, Coring, Cutting and Patching

B. System Requirements:

1. Install and integrate a completely functional Access Control, panic alarms, and related security hardware.
2. Configure local access panels in various telecommunication rooms (TR) and the Server's computer system to communicate with one another.
3. Enter security system data bases hardware configuration.
4. Test security system communication and operation in accordance with the specification
5. Train operators and the system managers.

C. Bidding Requirements:

1. Submit complete detailed proposals with line item cost representation for components and associated installation labor. Lump sum bids will not be accepted.
2. Include as part of the bid response the following items:
   a. Installation schedule with proposed manpower assignments
   b. Resumes for project manager and lead engineer for this project
3. Review associated "E" series electrical, low voltage infrastructure drawings to verify that necessary conduit and floor boxes will be provided by EC. The Owner will provide no additional infrastructure to support the Access Control system. Any discrepancies with the identified infrastructure to support these systems should be questioned in the form of a request for information (RFI) during the bidding process. This contractor shall be responsible for any additional infrastructure requirements after receipt of contract for this project.
4. Unspecified Equipment and Material: Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide complete and functional

Access Control Systems shall be provided in a level of quality consistent with other specified items.

1.2 REFERENCES

A. The Codes and Regulations listed below form a part of this specification to the extent referenced. Work shall be performed in accordance with the applicable international, federal, state, and local codes or standards current at the commencement of installation. The following list summarizes applicable standards though additional standards not listed may apply per AHJ:

1. UL 294, UL 1076, ULC.
2. CE
3. FCC – Part 15, Part 68
4. NFPA 70, NEC
5. IEEE, RS 170 variable standard
6. RoHS

B. Where more than one code or regulation is applicable, the more stringent shall apply.

C. Cable and equipment installation, identification, and termination shall be performed in accordance to the applicable codes above and system manufacturer's recommendations.

1.3 SYSTEM DESCRIPTION

A. Complete engineering, installation, programming, and maintenance of the access control system.

1.4 DEFINITIONS

A. SMS – Security Management System

1.5 SMS DESCRIPTION

A. All building and room access control systems shall be systems, equipment, and accessories compatible with the access control system. All auxiliary accessories or supporting devices shall be fully compatible with and able to integrate with existing campus system.

B. The SMS shall be able to seamlessly interface with and monitor intelligent system controllers, reader interface modules, I/O panels, burglar alarm panels, burglar alarm panel receivers, biometric devices, personal protection devices, intercom systems, fire alarm panels (secondary monitoring only), building management systems and digital video recorders.

C. The SMS shall be able to communicate with intelligent system controllers via RS-485, RS-232, TCP-IP/ Ethernet.

1.6 PERFORMANCE REQUIREMENTS:

A. All programming of all systems hardware is by the security contractor. A one year full parts and labor warranty is specified. Note that the full one year parts and labor warranty is unconditional and covers all portions of this system from failure, except misuse by the owner. During this one year period, the security contractor must meet the following performance requirements:

1. Respond onsite withing two (2) to four (4) hours.
2. Advanced loaners
3. Computerized dispatch
4. Available 7 days a week, 24 hours a day.

B. Four (4) hours of battery back-up is required on all access control panels in addition to supply from the emergency/standby generator.

1.7 SUBMITTALS

A. Comply with General Conditions for submittal procedures.

B. Informational Submittal: Submit a detailed bill-of-materials listing all part numbers and quantities for this project.

C. Qualification data:

1. List of all technical personnel

2. Identification in both quantity and dollars the amount of service inventory maintained locally on both service vehicles and your warehouse.

3. Resume of key project manager and lead technician

4. Contractor manufacturer authorize dealer certificate

5. Contractor manufacturer authorized installer certificate

D. Pre-Qualification Certificate as part of this proposal: Submit a letter of approval from the manufacturers indicating compliance with qualification requirements. Training certificates for design, engineering and installation of the proposed products shall be submitted with the proposal.

E. Service Dispatch: Submit as part of this proposal an outline containing the type of service program used for dispatching and tracking service calls.

F. Shop Drawings: Required before work can begin. Shop drawings will clearly indicate how work will be performed.

G. Product Literature Sheets: Provide a manufacturer's product cut sheet for each component of the system including each data gathering panel, computer, computer peripheral, alarm contacts, UPS, power supply, electronic locking device, delay locking device, or other device on the device schedule.

H. Detail Drawings: Provide a detail drawing for each type of door. This should also include device location on floor plans, wiring diagrams, and point-to-point charts, riser diagrams for each major subsystem, etc. Show each input and output terminal on each panel and identify it's use. If it is a spare, indicate this accordingly. Include on shop drawings the reader location s and show the reader controller to which they are assigned. Show the devices they work with such as electric locks, local audible alarms, door contacts, etc.

I. Project Directory: Provide a job directory of your company engineering and installation team including phone, fax, email or mail to each manager, engineer, sales rep, or installer involved in this project.

J. Block Diagrams: Submit block diagrams for each system indicating connections of equipment and indicating equipment types and model numbers.

K. Riser Diagrams: Provide riser diagrams of the access control system and any other system specified herein.

L. Field Devices: Submit details on items such as alarm detectors and contacts and card readers including their appearance and performance, specifications, and exact locations. Include on shop drawings the reader locations and show the reader controller to which they are assigned. Show the devices they work with such as electric locks, local audible alarms, door contacts, etc.

M. Manuals: Final copies of the manuals shall be delivered within fourteen (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. The manuals shall consist of the following available from the

manufacturer:

1. Functional design manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.

2. Hardware manual: The manual shall describe all equipment furnished including:

   a. General description and specifications

   b. Installation and check out procedures

   c. Equipment layout and electrical schematics to the component level

   d. System layout drawings and schematics

   e. Alignment and calibration procedures

   f. Manufacturers repair parts list indicating sources of supply

3. Software manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

   a. Definitions of terms and functions

   b. System use and applications software

   c. Initialization, start up, and shut down

   d. Reports generator

   e. Details on forms customizations and field parameters

4. Operators Manual: The operators manual shall fully explain all procedures and instructions for the operation of the system including:

   a. Computers and peripherals

   b. System start up and shut down procedures

   c. Use of system, command, and applications software

   d. Recovery and restart procedures

   e. Graphic alarm presentation

   f. Use of report generator and generation of reports

   g. Data entry

   h. Operator commands

   i. Alarm messages and reprinting formats

   j. System permissions functions and requirements

5. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

6. Manuals shall be delivered on CD/DVD in an organized fashion based on manufacturer and product.

N. As-Built Drawings: During system installation, maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the SMS to be used for record drawings. Set shall be accurately kept up to date with all changes and additions to the SMS. Copies of the final as-built drawings shall be provided to the end user in DXF or DWG format.

1.8 QUALITY ASSURANCE

A. Providers of manufactured components, installation, wiring and testing shall be the responsibility of a single contractor who is an authorized dealer for the product supplier and who has been continuously in business for a period of not less than five (5) years and is licensed as required by the jurisdictions where the work will occur to perform the work specified.

B. The installing contractor shall be a manufacturer registered authorized commercial installer.

C. The installing contractor shall be manufacturer certified Picture Perfect M5 system contractor. The contractor shall have experience with programming and working on existing Picture Perfect system.

D. The contractor shall have working knowledge of Alarm Safe relay panels.

E. Security License Requirements: Be licensed by the State of Massachusetts for a security license with the appropriate background checks.

F. Service Support: Provide post-sales service support for all components in the system design that meets these requirements:

1. Availability 7 days a week, 24 hours a day
2. Response time: 2 to 4 hours on-site.
3. Advance Replacement:
    a. Provide advance replacements for any component whenever it is required.
    b. Be able to provide advance loaners.

1.9 PERFORMANCE REQUIREMENTS

A. Technical Personnel: Have adequate technical staff located withing 50 miles of the Library.

B. Working Hours Response: During normal working hours, all telephone calls placed to the contractor shall be answered by a live person, not an auto-attendant.

C. Service Dispatch: Use a computerized service dispatch system that is a commercial off-the-shelf product used for dispatching service companies. At the end of every week, the contractor will be required to email the hospital a list of all service calls and their status on an automatic basis. Excel spreadsheets are not acceptable for a service dispatch program.

D. Have a dedicated position specifically for managing and dispatching service calls for their clients. This position shall perform no other functions except service-related dispatch functions and services.

E. Engineering: Have field-trained engineers on staff that are 100% conversant in AutoCAD or Revit and are able to provide the necessary electronic drawings and submittals required for a project of this size.

1.10 SUBSTITUTIONS AND QUALITY:

A. Where products are specified by name, provide and install that product. Substitutions will not be accepted for the access control system of their sub-systems.

1.11 DELIVERY, STORAGE AND HANDELING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

1.12 SYSTEM TRAINING

A. Training: Provide training in the operation and maintenance of the system for personnel designated by the Owner. The training shall be organized as follows:

1. Two (2) two-hour training classes for system technical operation and maintenance. These classes shall cover the following topics:
    a. Review of all equipment functions, relevant to the function in this system.

b. Review of initial equipment settings

c. Demonstration of all functional connections form a user perspective

d. Review of manufacturer's recommended routine maintenance procedures.

2. Eight (8) hours of training by a Manufacturer's Representative regarding system functionality and maintenance.

3. Training may take place at any time (chosen by the Owner) after the systems are operations, up to a year following system acceptance.

4. Close out submittals shall be provided prior to any training classes

5. Coordinate detailed specifics of the training sessions, time, date & location with the Owner.

1.13 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connection materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintain ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install equipment until spaces are enclosed and weather tight, wet work in spaces is complete and dry and work above ceilings is complete.

1.14 COORDINATION

A. Coordinate layout and installation of Access Control systems equipment with Owners security representative inclusive of the integrations to the existing system located in the Public Safety Communications Center.

1. Meet jointly with Owner to exchange information and agree on details of equipment arrangements and installation interfaces.

2. Record agreements reached in meetings and distribute them to other participants.

B. Coordinate layout and installation of the Access Control Systems cable pathways with telecommunications contractor.

1.15 COMMISSIONING AND START UP

A. Coordinate programming with Owner to show all controllers, door interfaces, input and output panels are installed and configured to properly interface and function.

B. Contractor is not responsible for card holder creation or badge production.

PART 2 - MATERIALS AND PRODUCTS

2.0 MATERIALS

A. General

1. All equipment and material for permanent installation shall be new unless specifically indicated otherwise. In addition, material shall:

a. Be without blemish or defect.

b. Not be used for temporary without prior written authorization from the Owner.

c. Be in accordance with NEMA Standards.

d. Bear UL label where subject to UL label service.

2.1 MANUFACTURERS

A. RS2, or approved equal

B. Honeywell International, Inc (panic devices)

2.2 ACCESS CONTROL BUNDLE

A. Plenum overall jacket, components listed below:

1. SHLD 18 awg-4/c (printed: lock power) plenum jacket

   a. Larger gauge wire may be required to compensate for voltage drop over longer distances in compliance with manufacturer's requirements/limitations.

2. SHLD 22 awg-3/PR (card reader) plenum jacket
3. SHLD 22 awg-2/c (door contact) plenum jacket
4. SHLD 22 awg-4/c (rex/spare) plenum jacket
5. Door monitor cable – SLD 22 awg-2/c plenum (door contact) plenum jacket.
6. Power cable – 16 awg – 2 conductor plenum jacket.
7. Lockout switch cable – 22 awg-2/c plenum jacket (lockout).
8. Cabling color shall be green

2.3 READERS

A. Provide appropriate licensing to include added equipment in this section to the existing configuration/system.

B. Standard Door Access Card Reader

1. Dimensions: 5.85"x 1.75" x 1.16" (T-500SW), 5.85" x 4.50" x 1.25" (T-520SW).
2. Power: 120mA at 12 Vdc (average).
3. Operating Temperature: -35 to +65 degrees Celsius.
4. Operating Humidity: 5% to 95% relative non-condensing.
5. Finish: Per Architect
6. Provide weatherized enclosure for exterior mounting locations
7. UV resistant materials
8. Provide mullion mount as required
9. LED visual indicator
10. Coordinate exact mounting location with door hardware installer.
11. Product: UTC Transition "T-500SW" and "T-520SW" Series

2.4 ACCESS CONTROL DEVICES

A. Provide appropriate licensing to include added equipment in this section to the existing configuration/system.

B. Provide star configuration for master controller/door controller interconnection

C. Input Control Module

D. Output Control Module

E. Single Reader Interface (SRI) Module

F. Dual Reader Interface (DRI) Module

G. Intelligent System Controller (ISC)

H. Star Multiplexer

I. Power Distribution Module

J. Multi-Output Access Power Controller

K. Lockable enclosure

2.5 POWER SUPPLIES

A. Power supply, 12 volt with enclosure

B. UL Listed, 115Vac, 1.6 amps input, 12Vdc 6 amps output

C. 24" x 18" x 4.5" enclosure, lockable, CAT 60 lock, tamper switch, power distribution module

D. Power Supplies and Enclosures: Altronix with battery kit

2.6 PANIC BUTTONS

A. Silent operation panic button, double pole, double throw contacts, stainless steel cover.

B. Concealed underneath desk with concealed wiring and cable management

C. Honeywell 269R Series.

2.7 DATA/NETWORK

A. One (1) assigned and static IP address accessible data port/connection shall be provided for each controller panel installed.

PART 3 - EXECUTION

3.0 BASIC REQUIREMENTS

A. Cooperation and Work Progress

1. The access control systems work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Contractor shall cooperate with the Architect, all other Contractors and equipment suppliers working at the site. The Contractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.

2. The Contractor shall coordinate their work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Contractor shall be assumed by him without any additional cost to the Owner.

3. The Contractor shall provide information on all equipment that is furnished under this Section but installed under another Section to the Construction Manager or as specified herein.

4. The Contractor shall provide all materials, equipment and workmanship to provide for adequate protection of all equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Contractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.

5. Waste materials shall be removed promptly from the premises. All material and equipment stored where exposed to the weather. The Contractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.

6. It shall be the responsibility of the Contractor to coordinate the delivery of the equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur.

7. The Contractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff, and the Public.

B. Installation

1. The Contractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.

2. The Contractor shall keep fully informed of size, shape, and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.

3. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.

4. All equipment and materials shall be installed and completed in a first-class workmanlike manner. The right is reserved to direct the removal and replacement of any item, which in the opinion of the Owner's and/or Architect/Engineer does not present an orderly and reasonably neat or workmanlike appearance, provided such items can be properly installed in an orderly way to usual methods in such work.

5. Preferred Installer

- Citywide Solutions – 844-395-4101, Mike@citywidesolutionsinc.com

C. Firestopping

1. Firestopping shall be provided by others to confirmed with the Owner's CM, not the Access Control System Contractor. Refer to Division 07 and Section 20 00 00.

2. Where conduits, wireway, and other raceways pass through fire partitions, fire walls or walls and floors, install a firestop that provides an effective barrier against the spread of fire, smoke, and gases. Fire-stop material shall be packed tight, and completely fill clearances between raceways and openings. Fire-stop material shall conform to the following:

a. Firestopping material shall maintain its dimension and integrity while preventing the passage of flame, smoke, and gases under conditions of installation and use when exposed to the ASTM 119 time-temperature curve for a time period equivalent to the rating of the assembly penetrated. Cotton waste shall not ignite when placed in contact with non-fire side during the test. Firestopping material shall be non-combustible as defined by ASTM E136, and, in addition, for insulation materials, melt point shall be a minimum of 1700°F for 2-hour protection.

3. Firestopping materials shall be installed in accordance with manufacturer's written instructions.

D. Material and Workmanship

1. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL approved and labeled.

2. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.

3. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.

4. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.

5. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.

6. The Owner will not be responsible for material, equipment, or the installation of same before testing and acceptance.

7. All equipment furnished with finished surfaces shall be cleaned to the original finish at the completion of the project.

E. Cleaning

1. This Section of the specifications shall include the cleaning of all equipment on a day- to-day basis and final cleaning of all equipment prior to turning building over to the Owner. All necessary cleaning referred to herein shall be cleaned to the satisfaction of the Architect.

3.1 GENERAL DESIGN STANDARDS

A. Access control system shall be designed and installed to not interfere with egress requirements for life safety nor interfere with intrusion or fire alarm systems.

B. All access controlled handicap entrances shall be fully integrated into the building access control system ensuring that while providing access to the disabled, that proper access control is maintained in both the unsecured and secured modes. Access control systems shall be installed to comply with ADA policies.

C. All access control installation shall use housing and mountings which maintain or minimize disruption to architectural sensibilities or themes of the buildings and campus.

D. All access control installation shall use housing and mounting designed to provide sufficient protection against tampering and vandalism. Torx center pin security fasteners shall be used on all devices installed in public areas.

E. All access control systems shall be configured to provide a 'fail secure' with mechanical manual egress from the secure side in the event of a loss of power, loss of network communications, or system failure.

F. All access control equipped doors locking hardware shall include keyed locking mechanisms accessible form the unsecured side to allow keyed manual operation of the door.

G. All access control equipped doors shall be keyed to a key system designated for access controlled doorways.

H. All access control equipped doors shall be equipped with door position monitors and request to exit devices to allow for configuration of door condition alarms.

I. All access controlled system equipment, including controllers and power supplies, shall be located in accessible and secure rooms with telecommunication/IDF rooms being preferred.

J. Electric power supplies and power converters for the access system equipment and hardware shall be connected in the Telecommunications/IDF room. Power supplies located at the access equipped door should be avoided.

K. Electrical service to access control power supplies shall be on dedicated circuits. Where practicable, electric power for the access system should be provided through the building emergency power supply.

L. All access control equipment power supplies shall be equipped with battery back up to allow operation if electrical service and emergency power is lost.

M. As a minimum, provide conduit from all access devices, hardware, and equipment to ceiling location to allow for convenient access to raceways for cabling.

N. All new construction installation of access control systems shall be hardwired.

O. Wiring Connection Requirements: All low voltage control, monitor, power, and other cables shall be

connected using sealed crimp type lugs, no wire nuts will be allowed.

P. Monitor Contacts: Door monitoring contacts, and wiring and conduits there to, shall be concealed and invisible when the door is closed. Externally applied door monitoring contacts, externally applied conduit or wiremold, and wire without conduit must be approved by Security or Project Manager.

Q. Request to Exit Switches: Request to exit (RX) switches should be mechanically hardware based devices. Passive infrared (PIR) or conic detectors should only be used when no mechanical method is available.

3.2 CONDUCTORS, WIRE, CABLES

A. Data

1. All access control system data wiring, cables, jumpers, and connectors will comply with requirements of Division 27 Communication construction standards.

B. Low Voltage Electrical

1. All access control system low voltage electrical wiring, cables, and connectors will comply with the requirements of Division 27 Communication construction standards.

2. All access control system low voltage electrical wire shall be rated and adequate to supply the intended doors full functionality including but not limited to lock mechanisms, readers, and monitoring points without exceeding 75% of the wire's rated capacity.

3. Distance from power supply to door lock should be examined to determine correct wire gauge to support expected voltage drop over distance.

3.3 CONTROLLERS

A. Controllers

1. All access control systems or controllers should be located in secure location with Telecommunications/IDF closets being preferred.

2. All access control system controllers and interface devices shall be housed in a metal case capable of being locked.

B. All access control system controller installations shall comply with requirements of Division 27 Communication construction standards

1. All access control system wireless transceivers/PIMs shall be mounted out of the public view with mounting in a secured room being preferred.

2. All access control system wireless transceivers/PIMs shall be housed in a metal case capable of being locked.

3. Attention should be given to avoid other equipment which might interfere with proper operation of controllers.

3.4 ELECTRICAL POWER NEEDS

A. All access control system power supplies should be located in secure location with Telecommunication/IDF closets being preferred.

B. Access control power cables shall not be installed to be in public view. Any power cables within public view shall be placed in conduit to prevent damage or tampering.

C. All access control power supplies shall be rated and adequate to supply all controllers, door locks, cared readers, and monitor devices without exceeding 75% of the power supply. In selection of power supply output, special attention should be paid to expected distance from power supply to door installation and resulting voltage drop over distance.

D. Access control power supplies shall be equipped to allow access system to detect and report building electrical power feed failure.

E. Access control power supplies shall be provided with plug or disconnect switch to terminate building electrical power.

F. A four gang electrical outlet connected to dedicated 20amp power supply shall be provided at each controller/power supply installation location.

3.5 ELECTRONIC ACCESS CONTROL ADMINISTRATION

A. Administration of the electronic access control infrastructure includes documentation of devices, cables, termination hardware, patching and cross-connection facilities, conduits, other cable pathways, and telecommunications closets.

3.6 RECORDS

A. A record is a collection of information about or related to a specific element of the access control system. Records must be maintained in a computer printable spreadsheet or in a computer database. Paper records are encouraged, but are optional. A device and cable record is prepared for each device/door installation. The record will show the device/door name, and must describe the components from origin point and destination point. The device and cable record will record what services and/or connections are assigned to each installed location based on Door Number. An equipment record is prepared for services distributed from a certain piece of equipment, such as a encoder, controller or a system.

3.7 LABELING AND COLOR CODING

A. It is important that both labeling and color coding be applied to all access control devices, wiring, and infrastructure components. Labeling with the unique identifier will identify a particular component. Proper color coding will quickly identify how that component is used in the overall systems infrastructure of the facility.

B. Labeling

1. Labels shall be applied to the wiring terminations and corresponding devices. Wiring and cable labels shall be applied at the doorway end and controller device side of cable and wiring runs.

2. Labels are generally of either the adhesive or insert type. All labels must be legible, resistant to defacement, and maintain adhesion to the application surface.

3. Outside plant labels shall be totally waterproof, even when submerged.

4. All labels shall be machine printed.

5. Labels applied directly to a cable shall have a clear vinyl wrapping applied over the label and around the cable to permanently affix the label.

6. Other typed of labels, such as tie-on labels, may be used. However, the label must be appropriate for the environment in which it is used, and must be used in the manner intended by the manufacturer.

C. Color Coding – Cable Termination Fields

1. Color coding shall be applied to all cables and cable termination fields in Telecommunications closets, equipment rooms, and entrance facilities. Color coding may also be used to identify specific cables in a pathway, or the function of specific equipment racks or equipment. The same color is always applied to both ends of any given cable. Cross-connections are generally made between termination fields of different colors. The color may be applied to the plywood backboard behind the termination block, may be the color of a plastic cover on a termination block, or may be the actual color of the insert label on a termination block or patch panel.

END OF SECTION

SECTION 282300

VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for VIDEO MANAGEMENT SYSTEM for the project.

B. Work includes furnishing all labor, materials, tools and equipment, and documentation required for a complete turnkey working system as specified in this Section. VMS shall consist of but not be limited to, Cameras, Monitors, Appliances, Conduit, Boxes, Cable and Wired Devices. Programming and camera view setup are considered part of installation as well as coordination with Owner for camera views.

C. Unless noted otherwise, "Contractor" shall refer to VMS Integrator & Installer.

D. Communications routing from VMS server or appliances to devices, (Cameras), shall be via Owner LAN.

E. Coordinate with any and all trade contractors as required to provide a fully functioning system.

F. Unless noted otherwise, "Contractor" shall refer to security system integrator & installer.

G. Video surveillance can be restricted or prohibited by law. This document details technical considerations only. It is assumed that registration, licensing, policies regarding disclosure and privacy (notification, processing of images, time and date stamping, recording of sound, etc.), and or legal obligations are responsibility of Owner.

1.2 RELATED WORK

A. Related Division 28 Sections include:

1. 281300 – ACCESS CONTROL SYSTEMS

B. Related Sections in other divisions of Work:

1. 270000 – VOICE/DATA SYSTEMS

1.3 REFERENCES AND STANDARDS

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 1 General Requirements.

B. All work and materials shall conform in every detail to rules and requirements of National Fire Protection Association, Kentucky Electrical Code,

C. All materials shall be listed by UL and shall bear UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label entire system shall be so labeled.

D. Other applicable standards are as follows:

1. ANSI/IEEE C2 - National Electrical Safety Code
2. NFPA 70-1999 - National Electrical Code
3. IEEE/ANSI 142-1982 – Recommendations for Grounding of Industrial & Commercial Power Systems.
4. NTSC/EIA RS-170A Video Standard
5. IEEE 802.3 standards for CSMA/CD (Ethernet) based LANs
6. Emissions: FCC 15, Class A; CE: EN55022 (Emissions)

7. CE: EN50082-01 (Immunity)
8. CE, UL 1950; CUL 1950 CE: EN60950 (Safety)
9. State of Ohio

1.4 DEFINITIONS AND ABBREVIATIONS

A. VMS – Video Management System

B. LAN – Local Area Network

1.5 WORK BY OWNER

A. Owner shall provide:

1. Verify exact security device mounting locations.
2. Verify Acceptable per-camera field-of-view information.
3. Enterprise-wide Data Network / LAN to be utilized by VMS system.
4. Cross-connections from VMS components to building LAN, contractor provides all interconnection cables (Patch Cables) as needed but may not connect to LAN without Owner IT Department oversight and approval.
5. All active LAN components (switches, routers) as required for Security system function.
6. IP-address allotment and management for VMS devices as needed.

1.6 SUBMITTALS

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

B. System Design drawings with cable routing, device location and labeling.

C. Communication and Security Closet layouts.

D. Camera View Modeling.

1.7 QUALITY ASSURANCE

A. Video Management System Contractor shall:

1. Have successfully completed two (2) Security Systems projects in equal magnitude of the system specified in following sections. Be fully certified by Avigilon Systems for Sales and Installation of equipment. Proper proof of certification will be submitted at time of Bid.

1.8 GUARANTEE

A. Warranty requirements for Video Management System (VMS) shall bet two (2) years on all parts and labor commencing on Date of Substantial Completion. Those requirements apply to all components covered in this section

PART 2 - PRODUCTS

2.1 GENERAL

A. VMS system shall deliver high quality; color video over an IP, UTP structured cable system using H.264 / H.265 compression and shall provide for monitoring and recording of all cameras in system as indicated herein and on project Drawings. The VMS allows event-based monitoring of situational awareness though IP cameras centrally managed from the Owners Operations Center. The VMS utilizes built in analytics to identify potential situations on and preserving evidence for authorities to review. The VMS has the capability to be securely monitored via mobile devices or off-campus locations, video sharing with outside public safety, first responders.

B. Video shall be configurable from a workstation on the Owners LAN using standard Browser software.

2.2 IP VIDEO CAMERA (FIXED)

A. Indoor Fixed Position Camera shall be: Hanwha Dome Camera or approved equivalent.

B. Outdoor fixed mounted camera shall be Hanwha Dome Outdoor Mount camera or approved equivalent.

C. Camera shall:

1. Be ceiling / wall mountable dome-type.
2. Be IP-native.
3. Utilize Power-over-Ethernet (PoE) for device power.
4. Be designed to provide video streams at the minimum HDTV 720p (1280x720) resolution at 30 frames per second using H. 264 / H.265.
5. Be equipped with Day/Night functionality, Wide Dynamic Range (WDR), color video to ½ lux, black and white below ½ lux and feature remote back focus capabilities.
6. Be provided complete with standard interior (3-9 mm nominal) auto-iris lens.
7. Per-camera lens selection dependent upon Owner-required field-of-view.
8. Have a smoked bubble.
9. Have housing and mount color to match surrounding architectural colors.

2.3 NETWORK VIDEO SERVER / APPLIANCE:

A. Manufacturer: Hanwha Wisenet Wave VMS

1. General:

- Rack-mounted

2. Video Storage:

- Provide proper number of Servers / Appliances to accommodate the number of cameras needed for the project. VMS must provide 30 Days of local storage for all cameras recording.
- Storage capacity calculations shall be based on 24/7 recording at a minimum 15 Frames Per Second.
- Future capacity of Fifty Percent (50%) should be included for future camera installations. This should be calculated in the number of Servers / Appliances provided for the project.

2.4 WIRE AND CABLE

A. General

1. Provide and install all device DATA cables as per Division 270000 requirements. DATA cabling for Security cameras shall be terminated in each DATA Closet, in approved labeled patch panels (As per Division 270000 requirements). Camera cabling should be terminated in jacks at the camera device. Contractor to provide all patch cables. All exterior camera cables shall be provided with Surge protection units on each cable. Proper cable types must be must as per Division 270000 requirements.
2. Provide all interconnecting system cabling at Security Closets and Communication Closets as well at security device end points. Bond metallic system components in all Communications Closets and Security Closets to existing in-room ground bar.
3. Confirm and provide any necessary interface cabling with existing Access Control system.

PART 3 - EXECUTION

3.1 GENERAL

A. Work performed for installation of VMS system shall be performed by Security System Integrator – "Contractor".

B. Preferred Installer

- Citywide Solutions – 844-395-4101, Mike@citywidesolutionsinc.com

C. Provide equipment as indicated on Drawings and specified herein.

D. Provide all labor and materials necessary to construct systems as described herein to include furnishing and installing all system equipment, interconnecting cabling, programming and start-up, software (including software upgrades and reprogramming as necessary), termination components, mounting hardware, incidentals, accessories, testing, labeling, documentation and training as detailed in following sections.

1. Neatly lace, dress and support cabling.
2. Coordinate any downtime with Owner.

E. Prior to installation:

1. Conduit and equipment back boxes are as required. Contractor is responsible for coordination with all trades to ensure that conduit and back boxes are correctly placed for VMS use. Contractor is responsible for coordinating installation of conduit and boxes to make sure they are installed on schedule with other trades and are coordinated as to not interfere with other systems or pathways.
2. 120V AC Power is as required and is properly located.
3. LAN structured cabling is as required and properly located and installation has been coordinated with other trades.
4. Coordinate all devices and locations prior to equipment installation with owner.
5. Coordinate Owner-desired camera views, providing camera modeling prior to installation.
6. Coordinate Camera housing and mount finishes with Architect and Owner.

F. Install and wire equipment in accordance with Industry Standards, manufacturer's recommendations, and accepted engineering and installation practices.

G. Mount system components as recommended by manufacturer. All equipment mounting in Communication Closets must be approved by Owner IT Department prior to installation.

1. Arrange equipment to facilitate permanent access for use and maintenance.

3.2 CABLE INSTALLATION

A. Neatly lace, dress and support cabling.

B. Pull cables in accordance with cable manufacturer's recommendations and ANSI/EEE C2 Standards as well as all Division 270000 requirements.

1. Do not exceed manufacturer's recommended pulling tensions.
2. Do not install bruised, kinked, scored, deformed, or abraded cable.
3. Do not splice cable between indicated termination, tap, or junction points.
4. Remove and discard cable where damaged during installation and replace it with new cable.
5. Pull all cable by hand unless installation conditions require mechanical assistance.

C. Run all wire and cable continuous from device location to final point of termination. No mid-run cable splices shall be allowed.

D. Furnish and install all cable such that ample slack is supplied at device terminating end of cable to compensate for any final field modifications in camera location.

1. Loosely coil slack in "Figure-eight" in a manner that prevents kinking.
2. Loop radius shall be at least 4X minimum bend radius for cable.

3. Slack length of cable shall be 4 feet (minimum).

E. Provide code compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of Video System.

F. Coordinate routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc. with Engineer.

G. At no time shall any cable be subjected to a bend less than manufacturer's specified minimum radius.

H. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on Wire and Cable.

I. Make connections with solder-less devices, mechanically and electrically secured in accordance with manufacturers' recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.

3.3 IP VIDEO CAMERAS

A. Mount Video Cameras per project drawings.

B. Field-verify exact locations and field-of-views with Owner prior to installation.

C. Provide video camera lenses to accommodate Owner-coordinated field-of-view per camera.

1. Field verify and confirm views with Owner prior to procurement and final installation and adjust camera positions and lens sizes as required upon installation.

D. Configure resolution, frame rate, password, etc. to match existing system installation, coordinate with Owner.

E. Coordinate with Owner prior to installation to confirm required parameters.

F. Wire interface(s) to external alarms.

G. Provide Owner IT Department with Camera counts and camera information including POE Port required for project, Camera MAC addresses and any static IP requirements.

3.4 LABELING AND IDENTIFICATION

A. Labeling protocols to match all Owner Security System installations.

1. Cabling, Hardware and Equipment shall be clearly labeled using a Code identifying each piece as unique throughout Video Camera System. This code will aid in identifying hardware for servicing and maintenance.
2. Labels and Tags shall be machine-generated using English character set in black ink on white background labels and Tags.

- Self-laminating permanent labels are required on cables; permanent non-marring labels are required on all other hardware/cabinets.
- No hand-written Labels or Tags shall be allowed.
- Dymo or Kroy type adhesive backed lettering is not acceptable.

B. Identify and tag all cables to denote function.

1. Tag shall indicate:

- System of which cable is a part,
- Indication of cable destination (e.g. room or component), and
- Unique alpha-numeric identifier that distinguishes cable from all others in system.

C. All labels shall be machine generated. Handwritten labeling is not acceptable.

D. Label all front panel controls used in normal operation of system using plastic laminate engraved labels or approved equal.

1. Firmly affix to panel or device.

E. Labeling Formats

1. To be defined by Owner prior to construction following practice for all campus Security System installations.

3.5 SYSTEM TESTING AND ACCEPTANCE

A. System shall be complete and fully operational before requesting final acceptance.

B. Installation of all field devices will be inspected by Owner or Owner's representative. Inspection will consider overall neatness and quality of installation, functionality of each individual device, mounting, wiring and labeling.

C. Conduct a seven-day burn-in test. Intent of burn-in test shall be to prove System by placing it in near real operating conditions prior to inspection by Owner.

1. During this period System shall be fully functional and programmed so that all points, controls, messages, prompts, etc. can be exercised and validated.

D. Provide written notification to Owner that system is completely installed, integrated, burn-in testing completed and is fully functional as specified herein.

1. Submit schedule for acceptance testing. Representatives of Owner, may witness test procedures.
2. Notify Owner and the representative in writing a minimum of two weeks in advance to allow for such participation.
3. Describe test procedures prior to testing and submit sample test form to Owner / Representative.

E. Prior to final acceptance test, equipment rooms and similar areas should be free of accumulation of waste materials or rubbish caused by operations under Contract.

F. Equipment shall be on and fully operational during any and all testing procedures.

1. Provide all personnel, equipment, and supplies necessary to perform site testing.
2. Supply a form of communication with remote parties in the team for use during test.
3. A manufacturer's representative shall be present on site to answer any questions that may be beyond technical capability of Contractor's employees, if Contractor so elects or by specific request of Representative Owner, at no charge to Representative or Owner.

G. During course of final acceptance test, Contractor shall be responsible for demonstrating that, without exception, provided VMS complies with contract requirements.

H. Testing shall include but not be limited to:

1. Continuity and conductor/connector integrity on all cables.
2. Demonstrate functionality of all cameras including:

- Owner-acceptable field of view.
- Response to alarms.
- Response to Access Control System inputs.

3. Confirm remote viewing, configuration and camera control via Browser and in the Owner Operations Center. Confirm all Analytic uses on Cameras programmed for Analytic use.

- Confirm system rights settings for authorized users.

4. Demonstrate storage and retrieval of recorded video by date/time.

I. Owner retains the right to suspend and/or terminate testing at any time when system fails to perform as specified.

1. In event it becomes necessary to suspend test, Contractor shall work diligently to complete / repair all outstanding items to condition specified in Specification and as indicated on Security Drawings.
2. All of Owner's / Representative Fees and expenses related to suspended test will be deducted from Contractor's retainage.
3. Contractor shall supply Owner with a detailed completion schedule outlining phase by phase completion dates and a tentative date for a subsequent punch list retest.
4. During final acceptance test, no adjustments, repairs or modifications to system will be conducted without permission of Owner.

J. Upon successful completion of final acceptance test (or subsequent punch list retest) Owner or Representative will issue a letter of final acceptance.

K. Records of Test Results shall be included in System Documentation and submitted as detailed below.

3.6 OWNER TRAINING

A. Training course for system covered in this section shall be a minimum of 8-hours.

B. Maximum number of students to be (6).

1. Training materials shall be provided to all students.

C. Record, label, and catalog all training on DVD Videodiscs. Provide discs to Owner for future in-house training sessions and / or reviews. Furnish all temporary equipment necessary for taping all training sessions. Maintain accurate and up-to-date time sheets of all training sessions.

D. Contractor shall be on call during Warranty period to answer any questions Owner might have. The Owner reserves the right to use any excess training hours, not used by time of system completion, for future training as requested by Owner until total number of training hours has been completed.

3.7 DOCUMENTATION

A. All Owners manuals and or maintenance information shall be provided in printed form as well as electronic PDF format to the owner and owner representative.

3.8 WARRANTY AND SUPPORT

A. Unless otherwise noted, Contractor shall guarantee all materials, equipment, etc., two (2) years from date of final Owner acceptance of system. This guarantee shall include all labor, material and travel time.

B. Contractor/Integrator and/or manufacturer(s) of system equipment must offer:

1. Technical Support Capabilities (Technician onsite) response time onsite within 4 hours, 24-hours/7-days per week ("24/7"), and 365 days per year.
2. 24-hour turn-around (from receipt of item) for Repair or Replacement of failed components, 7-days per week

END OF SECTION

SECTION 284613

ADDRESSABLE FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Description: This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire detection equipment required to form a complete, operative, coordinated system.

B. Section Includes:

1. Analog-Addressable fire-alarm system.
2. Fire-alarm control unit (FACU).
3. Manual fire-alarm boxes.
4. System Detectors.
5. Fire-alarm notification appliances.
6. Fire-alarm annunciators.
7. Fire-alarm addressable interface devices.
8. Fire-alarm system communications.
9. Fire-alarm system accessories.
10. Fire-alarm conductors and cabling.

1.3 REFERENCES

A. Abbreviations and Acronyms

1. DACT: Digital alarm communicator transmitter.
2. FACU (FACP): Fire-alarm control unit (panel).
3. NAC: Notification Appliance Circuit
4. NICET: National Institute for Certification in Engineering Technologies.
5. NRTL: Nationally Recognized Testing Laboratory.
6. SLC: Signaling Line Circuit

B. Definitions

1. Circuit: Wire path from a group of devices or appliances to a control panel or transponder.
2. Zone: Combination of one or more circuits or devices in a defined building area

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

1. National Electrical Contractors Association (NECA):
   a. NECA 305, "Standard for Fire Alarm System Job Practices".

1.4 COORDINATION

A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.5 SUBMITTALS

A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.

B. Product Data: For each type of product, including furnished options and accessories.

C. Shop Drawings: Provide for the fire alarm system.
   1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
   2. Include floor plans drawn to scale which clearly show locations of devices, equipment. Indicate electrical power connections, approximate location and size of conduit/wiring runs, and other information required to clearly describe the proposed system. Plans should include identification numbers and wiring connections for all equipment and devices in entire fire alarm system.
   3. Include enlarged plans, drawn to a scale not less than 1/4 -inch equals 1 foot, for all equipment rooms and any fire command centers with dimensioned equipment layouts.
   4. Include detailed riser diagrams based on the project floor plans, with all devices indicated along with proposed circuit routing. The conductor composition for each conduit section shall be provided. Show consecutive connections for all devices with addresses, candela ratings.
   5. Provide scaled elevations, sections, and details, including critical dimensions and details of attachments to other Work.
   6. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
   7. Detail assembly and support requirements.
   8. Annunciator panel details as required by authorities having jurisdiction.
   9. Include current draw for each device submitted and the listed minimum voltage required to operate.
   10. Include voltage drop calculations for notification-appliance circuits. Provide maximum allowable voltage drop for panel and for individual NAC circuits.
      a. Identify Notification Appliance Circuits (NAC) current draws and voltage drops for each circuit. Vendor must utilize the "end of line" method for voltage drop calculations. The "mid-point" method is not acceptable. In no case shall the calculated voltage at any notification appliance fall below the minimum listed operating voltage for the devices used.
      b. The voltage drop at EOL must not exceed 14% of the expected battery voltage, after the required standby time plus alarm time. Determine "worst case" voltage at far end of each NAC, by subtracting its calculated V-drop from the expected battery voltage. The result must be no less than the minimum listed operating voltage for the alarm notification appliances used. All these calculations must be placed on a dedicated sheet, for future reference by fire alarm service technicians.

11. Include battery-size calculations showing battery capacity and supervisory and alarm standby power requirements.
    a. Use manufacturer's battery discharge curve to determine expected battery voltage after specified time period of providing standby power. Then use calculated Notification Appliance Circuit current draw in the alarm mode to determine expected voltage drop at End of the Line Resistor (EOL), based on conductor resistance per conductor manufacturer's data sheet or NEC.
12. Include system response matrix showing the fire alarm system's actions (outputs) required for each type of alarm, supervisory, and trouble signal. Any non-compliant features must be fully described.
13. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.
14. Include performance parameters and installation details for each type of detector.
15. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
16. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Provide control wiring diagrams and show equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
    c. Locate detectors in accordance with manufacturer's written instructions.
17. Include equipment rack or console layout, grounding schematic, power calculations, and single-line connection diagram.
18. Include manufacturer's detailed installation instruction for the Fire Alarm Control Panel and all duct mounted smoke detectors, flow switches, tamper switches, supervisory switches, and similar items which require mechanical installation.

D. Delegated Design: For notification appliances and detectors, in addition to submittals listed herein, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional responsible for their preparation.

1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

E. Qualification Data: For Certified System Designer, Lead Technician, and Installers including names, license numbers, and certifications as described under Quality Assurance.

F. Sample Warranty.

G. Field quality-control reports.

H. Closeout Submittals

1. Operation and Maintenance Data: For fire-alarm systems and components to include in operation and maintenance manuals.
2. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
    a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
c. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
   1) Equipment tested.
   2) Frequency of testing of installed components.
   3) Frequency of inspection of installed components.
   4) Requirements and recommendations related to results of maintenance.
   5) Manufacturer's user training manuals.
d. Software and Firmware Operational Documentation: Provide operating manuals and backups of software database on USB media. The database provided shall be useable by any authorized and certified distributor of the product line, and shall include all applicable passwords necessary for total and unrestricted use and modification of the database.

1.6 MAINTENANCE MATERIAL

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

1. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
2. Manual Fire Alarm Boxes: 2% of installed quantity.
3. Audible and Visual notification appliances: 1% of installed quantity for each type.
4. Addressable Detectors/Bases: 2% of installed quantity for each type.
5. Addressable Control Relays: 1% of installed quantity.
6. Monitor Modules (Addressable Interface): 1% of installed quantity.
7. Isolation Modules/Isolation Bases: 1% of installed quantity.

B. Keys and Tools: Two extra sets for access to locked or tamper-proofed components.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. Manufacturer must be regularly engaged in manufacture of fire alarm systems of types, sizes, and electrical characteristics required, and whose products are Listed and Labeled.
2. Manufacturer shall maintain an authorized distributor within 100 miles of the project location which stocks a full complement of parts for all equipment to be furnished.

B. Installer Qualifications

1. Obtain certification by NRTL in accordance with NFPA 72.
2. Licensed or certified by authorities having jurisdiction to perform fire alarm installations in the specified jurisdiction.
3. Be in business a minimum of 5 continuous years with documented experience installing fire alarm systems similar in size and scope.
4. Installer must be responsible for all program changes and must be present for all testing and inspections.
5. All connections to the FACP and the system's programming shall only be done by the manufacturer, or by an authorized distributor.

C. Project Personnel Requirements: Installer must have the following certified full-time employees on staff and assigned to the project.

1. All personnel must be trained and certified by manufacturer for installation of units required for this Project.
2. System Designer: Preparation of shop drawings, cabling administration drawings, and field-testing program development by a NICET certified Level IV technician who shall be trained and certified in fire alarm system design by the approved manufacturer within the last 36 months and be licensed by the authorities having jurisdiction.
3. Lead Technician: Minimum NICET certified Level III technician who shall provide all devices, connections, and programming for the fire alarm system. Technician shall be certified by the approved manufacturer within the last 36 months and licensed by the authorities having jurisdiction. The lead technician shall be present at all times when work of this Section is performed at the project site.
4. Installer Qualifications: Any work related to this section shall be installed by personnel trained and certified by the approved manufacturer within the last 24 months.

1.8 WARRANTIES

A. Manufacturer Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship for a period of 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to the authority having jurisdiction, and marked for intended location and application.

B. All components provided shall be listed for use with the selected system.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Edwards EST
2. Notifier
3. Siemens by Distribution Channel Only
4. Simplex

B. Being listed as an acceptable Manufacturer in no way relieves obligation of the Contractor to provide all equipment and features in accordance with these specifications.

2.3 ADDRESSABLE FIRE ALARM SYSTEM REQUIREMENTS

A. Noncoded, UL-certified, FM Global-approved, Networked analog/addressable system, with multiplexed signal transmission and horn/strobe evacuation.

B. The system shall be designed, inspected, tested and approved to provide occupant notification audibility levels of 15 dBA over ambient conditions.

C. Fire Alarm System shall supervise and monitor the integrity of all sub-systems, circuits, and devices connected to the system and annunciate all system faults. All intelligent initiating, signaling, and control devices shall be individually addressed.

D. The system shall be fully programmable so that any type of input event can be correlated to any combination of output functions.

E. The fire alarm system operational priority shall ensure that life safety functions takes precedence over other activities coordinated by the system.

2.4 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.

B. Fire-alarm signal must initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit and any remote annunciators. The system alarm LED shall flash and a local distinct audible signal in the control panel shall sound.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch HVAC equipment controls to fire-alarm mode.
7. Activate emergency lighting control.
8. Record events in system memory.
9. Record events by system printer.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Duct smoke detectors.
3. Device tamper.
4. Zones or individual devices have been disabled.

D. System Supervisory Signal Actions:

1. Identify specific device initiating the event at fire-alarm control unit and remote annunciators. The corresponding system LED shall flash and a local distinct audible signal in the control panel shall sound.
2. Record the event on system printer.
3. Transmit a supervisory signal to the remote alarm receiving station with no time delay.

E. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable device or networked panel.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal AC voltage at fire-alarm control units.

7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Smoke Detector Contamination.

F. System Trouble Signal Actions:

1. Identify specific device initiating the event at fire-alarm control unit and remote annunciators. The system trouble LED shall flash and a local distinct audible signal in the control panel shall sound.
2. Record the event on system printer.
3. Transmit a trouble to the remote alarm receiving station after a programmable time delay of 200 seconds or as required by AHJ.
4. A trouble signal from loss of primary power shall not be transmitted unless maintained after a programmable time delay of 1 to 3 hours or as required by AHJ.
5. Fire alarm signal shall override trouble signals, but any pre-alarm trouble signal shall reappear when the panel is reset.

2.5 FIRE ALARM CONTROL PANEL (FACP)

A. General Requirements for Fire Alarm Control Panel:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with NFPA 72 and UL 864, and protected from voltage surges and line transients.

    a. System software and all control-by-event programs shall be held in nonvolatile memory, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer. Time-of-Day and date shall be retained through failure of primary and secondary power supplies.
    c. The Central Processing Unit (CPU) shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the CPU.
    d. Provide communication between the FACP and intelligent detectors, addressable modules, local and remote operator terminals, remote circuit interface panels, annunciators, and other system-controlled devices.
    e. The FACP shall be listed for connection to a central-station signaling system service.
    f. The system is to have multiple access levels, so owner's authorized personnel can disable individual alarm inputs or normal system responses (outputs) for alarms, without changing the system's executive programming or affecting operation of the rest of the system. A minimum of two different password levels shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

2. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
3. The system shall perform time-based control functions including automatic changes of specified smoke detector sensitivity settings.
4. Digitized electronic signals shall employ check digits or multiple polling. In general, a single ground or open on any system signaling line circuit shall not cause system malfunction, loss of operating power, or the ability to report an alarm.

5. Loss of Power: Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three lines of 80 characters, minimum.
2. Alphanumeric Touch Keypad: Arranged to permit entry and execution of programming, display, and control commands.
3. Color coded system status LEDs. At minimum, Indicate the status of the following system parameters:
   a. System AC Power
   b. System Common Alarm
   c. System Common Trouble
   d. System Supervisory
   e. Signal Silence
4. Provide operator's interface which allows the following minimum functions. In addition, the operator's interface shall support any other functions required for system control and/or operation:
   a. Signal Silence Switch: Silenced audible signal shall resound in a time period acceptable to AHJ if the condition has not been resolved.
   b. System Reset Switch
   c. System Test Switch
   d. Panel Silence Switch
   e. Panel Lamp Test Switch
   f. System Bypass Switches: Programmable, supervised switches for fire safety function bypasses. i.e. NAC Bypass, Elevator Capture Bypass, HVAC Shutdown Defeat, Smoke Control Bypass, etc. Switch operation shall be password protected.
   g. Interface shall allow programming of the system without any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

C. Notification-Appliance and Signaling-Line Circuits:

1. Signaling Line Circuits (SLC): NFPA, Class B.
   a. Provide a minimum of one signaling line circuit per floor.
   b. Locate end of line resistors
2. Notification Appliance Circuits (NAC): NFPA 72, Class B.
3. SLC Between Networked Panels: NFPA 72, Class X.
4. Size each signaling line circuit and notification appliance circuit to allow a minimum additional capacity of 20%.

D. Signaling Line Circuit (SLC) Modules:

1. Power limited, capable of accommodating up to 198 addressable devices on each SLC and a minimum of 1980 initiating points per system.
2. On-board microprocessor capable of operating in a local mode in the event of a failure in the main CPU of the control panel.
3. Capable of receiving analog information from all intelligent detectors and processing the information to determine whether normal, alarm, or trouble conditions exist for specific detectors.
4. Automatically maintain detector desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. Analog

information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

E. Notification-Appliance Circuit (NAC) Modules:

1. Power limited, minimum circuit output rating: 2 Amps at 24VDC.
2. Polarized to provide for both synchronized strobes and independent horn/strobe operation over two wires.
3. Selectable as auxiliary power outputs and rated for continuous duty.

F. Serial Interfaces:
1. One USB port for system printer.
2. One USB or Ethernet port for on-site programming or system modification with a PC.

G. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

H. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to and powered by fire-alarm system.

I. Remote Smoke-Detector Sensitivity Adjustment and Testing: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out final adjusted values on system printer. The system shall also annunciate a trouble condition when any smoke detector approaches 80% of its alarm threshold due to gradual contamination, with an annunciation of the location of the smoke detector requiring service. If any specialized equipment must be used to program any function of the smoke detector devices, then one must be furnished as part of the system.

J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station in accordance with parameters specified herein.

K. Primary Power: Obtained from dedicated 120-V ac branch circuit and a high efficiency power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Power supply modules shall have a continuous rating adequate to power all equipment and functions in full alarm continuously. All modules and drivers must be able to withstand prolonged short circuits in the field wiring, either line-to-line or line-to-ground, without damage. The power supply shall be expandable for additional notification appliance power in 3.0 Ampere increments.
2. Each system power supply shall be individually supervised.
3. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating to allow for future system expansion.
4. Install lock clips on circuit breakers in the “ON” position.

L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch for system operation in the event of primary power source failure.

Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm.

1. Batteries: Maintenance-free, rechargeable, sealed, lead acid with rated lifespan of 10 years.
2. Provide sufficient capacity to operate the complete alarm system in normal, supervisory, or trouble conditions, including audible trouble signal devices, mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm notification devices in alarm mode for a period of 15 minutes. Battery capacity must include a 25% safety factor.
3. Locate batteries either within the control panel or in a separate substantial steel cabinet, finished on inside and outside with enamel paint. Provide a cylinder lock keyed to match FACP. Separate cells to prevent contact between terminals of adjacent cells and between terminals and other metal parts.
4. Battery Charger: Provide solid state automatic float type, capable of dual rate charging techniques that will recharge a fully discharged battery to a minimum 70% capacity in 12 hours or less. Locate charger within the control panel or within the battery cabinet. Provide voltmeter and ammeter to indicate battery voltage and charging current.
5. All standby batteries shall be continuously monitored by the power supply. The power supply shall be able to perform an automatic test of batteries and indicate a trouble condition if the batteries fall outside a predetermined range.

M. Enclosure: Provide the FACP with a listed cabinet suitable for surface or semi-flush mounting. Cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be hinged on either the right or left side (field selectable).

N. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.6 REMOTE POWER SUPPLIES

A. Stand-alone panel capable of powering a minimum of four synchronized NACs. Power limited, 24 VDC, filtered-regulated, and supervised. Configurable as a continuous 24VDC auxiliary power output.

B. Alarms from the host fire alarm control panel shall signal the NAC remote power supply panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble conditions to the host panel.

C. Internal Primary and Secondary power supplies: comply with performance requirements for FACP.

2.7 MANUAL FIRE ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type with visual indicator of operation; with screw terminals and integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control panel. When the station is operated, the handle shall lock in a manner showing visual indication of operation.
2. Station Test/Reset: Key-operated test/reset switch. Stations shall be keyed alike with the fire alarm control panel.
3. Manual pull stations that initiate an alarm condition when opening the unit are not acceptable.
4. Indoor Protective Shield: Provide factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: At wet locations, provide factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
6. Material: High impact Lexan Polycarbonate or Cast Metal.
7. Suitable for ambient temperatures up to 120 deg F.
8. Where required, provide weatherproof backbox and device listed for outdoor applications.

2.8 SYSTEM DETECTORS

A. General Requirements:

1. Operating Voltage: 24VDC, nominal. Two-wire type.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP through a SLC.
3. Device Identification: Detectors shall permanently store an internal identifying type code that the control panel shall use to identify the type of device.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: dual LED type. LEDs shall flash under normal conditions, indicating that the device is operational and in regular communication with the control panel. The flashing mode operation of the detector LEDs shall be optional through the system field program.
7. Automatic Device Mapping: Detector address must be accessible from FACP and must be able to identify detector's location within system and its sensitivity setting.
8. Detectors shall be rated for operation in the following environment unless noted otherwise:
    a. Temperature: 32 deg F to 120 deg F
    b. Humidity: 0-93% relative humidity, non-condensing
9. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
    a. Multiple levels of detection sensitivity for each sensor.
    b. Sensitivity levels based on time of day.
    c. Automatically compensate for detector sensitivity changes due to ambient conditions and dust build-up within detectors.
10. Test Means: Provide a test means whereby detectors will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself or initiated remotely on command from the control panel when in the "test" condition.

B. Photoelectric Smoke Detector: Comply with UL 268.

1. Intelligent photoelectric smoke detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
2. Each detector shall utilize an environmental compensation algorithm that shall automatically adjust for background environmental conditions such as dust, temperature, and pressure.
    a. Provide a maintenance alert signal when 80% of the available compensation range has been used.
    b. Provide a dirty fault signal when 100% or greater compensation has been used.
3. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor compensation range (normal, dirty, etc.).

C. Duct Smoke Detector: Comply with UL 268A.

1. Listed for air velocity, temperature, and humidity present in specific duct application with standard Intelligent Photoelectric Detector and detector mounting base.
2. Duct Housing Enclosure: NRTL listed for use with supplied detector for smoke detection in HVAC system ducts. Provide gasketed NEMA 4X housing for harsh environments.
3. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
4. Relay Fan Shutdown: Fully programmable supervised relay rated to interrupt fan motor-control circuit.

D. Heat Detector: Comply with UL 521.

1. Heat detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements.
2. Fixed Temperature Type: Actuated by fixed temperature of 135 deg F unless otherwise required.
3. Combination Type: Actuated by fixed temperature of 135 deg F or rate of rise that exceeds 15 deg F per minute unless otherwise required.
4. Rated for ceiling installation at a minimum of 50 ft centers and suitable for wall mount applications.

E. Multicriteria Detector

1. Multi-criteria optical smoke sensor with integrated rate of rise sensing and optional carbon monoxide detection.
2. Integrated nuisance rejection to reduce unwanted alarms.
3. Provide independent signals to the control panel for detectors with CO sensors.

F. Electro-chemical Carbon Monoxide (CO) Detector: Comply with UL 2075.

1. Initiates a Temporal 4 tone when paired with a sounder base for local audible notification.
2. Transmit a maintenance condition to the control panel when the sensor approaches the end of its useful life.
3. Capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.

G. Detector Bases: Suitable for mounting to standard 4-inch octagon or square outlet boxes.

1. Standard Base: Twist lock, suitable for all intelligent detectors. Provided with integral terminal strips for circuit connections, rather than wire pigtails. Capable of supporting a remote alarm indicator light.
2. Relay base: Includes programmable, supervised relay, configurable for control with attached detector or from the FACP. Minimum contact rating of 1 amp at 30VDC and listed for pilot duty.
3. Sounder Base: Includes piezoelectric sounder with configurable low or high output, programmable operation, listed to UL 268. Produces Temporal Code 4 tone for CO detectors and Temporal Code 3 tone for all other detectors. or low frequency 520Hz signal tone patterns.
4. Low Frequency Sounder Base: Emits 520Hz tone as defined by NFPA 72 for sleeping areas, listed to UL 268 and UL 464.
5. Isolator Base: Includes integral isolation module.

2.9 NOTIFICATION APPLIANCES

A. General Requirements

1. Connected to system notification-appliance signal circuits, zoned as noted, equipped for mounting as indicated, and with in and out screw terminals for system connections.
2. All visual appliances shall be synchronized. Light and audible output levels shall be designed to meet ADA and NFPA requirements.
3. Audible/Visual Combination Devices shall comply with all applicable requirements for both Audible Notification and Visible Notification Appliances.
4. Devices located in a damp or wet location shall be listed for environment. Exterior mounted devices shall be provided with a weatherproof backbox.
5. Devices located in sleeping areas shall produce a low frequency alarm signal that has a fundamental frequency of 520Hz +- 10% and shall be a square wave.
6. All notification appliances shall be factory finished red unless noted otherwise on the drawings

B. Fire Alarm Audible Notification Appliances:

1. Description: Electric vibrating polarized Horns or other notification devices that cannot output voice messages.
2. Performance Criteria: Comply with UL 464.
3. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
4. Locate audible devices to provide audibility requirements of “Notification Appliances” chapter in NFPA 72.
5. Voltage: 24VDC nominal
6. Mounting: Flush mount on a standard electrical box.
7. Minimum rated sound pressure level of 85dBA at 10 feet for a thee pulse temporal pattern.

C. Fire Alarm Visible Notification Appliances: LED strobe lights with clear high impact polycarbonate lens mounted on an aluminum faceplate, complying with UL 1971. The word "FIRE" is engraved in minimum 1-inch- high letters on the housing.

1. Rated Light Output:15/30/75/110cd or 135/177/185cd, switch selectable at the device. Selected strobe rating shall be visible when the horn-strobe is in its installed position.
2. Voltage: 24VDC nominal
3. Mounting: Wall or ceiling mounted to standard electrical box unless otherwise indicated.
4. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
5. Flashing shall be in a temporal pattern, synchronized with other units. Maximum pulse duration: 2/10ths of one second.

6. Strobe Leads: Factory connected to screw terminals.

D. Bell: Vibrating under dome type with 10-inch gong, utilize a heavy-duty mechanism, polarized for supervised operation.

1. Voltage: 24VDC nominal.
2. Mounting: Semi-Flush mount on a standard electrical box.

2.10 ANNUNCIATORS

A. Fire Alarm Remote Annunciator

1. Description: Annunciator functions must match those of FACP for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACP, including acknowledging, silencing, resetting, and testing.
2. Mounting: Flush cabinet, NEMA 250, Type 1.
3. Annunciator shall communicate with the fire alarm control panel via a supervised RS-485 communications loop that supports multiple annunciators and shall individually annunciate all zones in the system.
4. Display Type and Functional Performance: Large format LCD Alphanumeric display and LED indicating lights must match those of FACP. Provide manual control switches to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.
5. Power shall be supplied directly from the FACP or listed auxiliary power supply, ensuring a reliable and monitored power source.

2.11 ADDRESSABLE INTERFACE DEVICES

A. General Requirements:

1. Arrange to monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and control of building systems.
2. All Circuit Interface Devices shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions.
3. Equip each module with two (2) diagnostic indicators; a green LED to confirm communications and a red LED to display active status. LEDs shall be visible through the finished cover plate. The module shall be capable of storing a unique serial number and up to 24 diagnostic codes, hours of operation, number of alarms and troubles, and time of last alarm in its memory which can be retrieved for troubleshooting.
4. Include electronic address-setting means on the module.

B. Monitor Module: Microelectronic module providing system address for alarm-initiating devices in wired applications with normally open contacts.

1. Supervision: Unless specifically noted otherwise on the drawings provide one monitor module for each sprinkler flow, tamper, and pressure switch.

C. Control Relay Module: For control of auxiliary devices or equipment.

1. Provide form C dry relay contacts rated 24VDC at 2 amps.

D. Isolation Module: For short circuit protection on signaling line circuits.

1. When a short circuit is detected, the module isolates the affected segment on the circuit, allowing the remaining devices to continue functioning.

2. Self-restoring and automatically reconnects to the circuit segment when the fault is removed.
3. SLC isolation shall be provided for each floor or protection zone of building.

2.12 DIGITAL ALARM COMMUNICATIONS

A. UL 864 listed as conforming to the requirements of NFPA 72 for Central Station connections.

B. IP/Cellular digital alarm communications transmitter (IP DACT): capable of sending system events to compatible remote central station receivers over a cellular or IP path.
1. UL 864 listed as conforming to the requirements of NFPA 72 for Central Station connections.
2. TCP/IP Ethernet Communicator supporting encrypted communications.
3. Cellular Communicator: LTE fall back cellular connection through the cellular module. Provide antenna extension kits where required to ensure a high-quality connection.

C. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture a transmission line and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If primary service is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of primary line to the remote alarm receiving station over the remaining transmission line. Transmitter shall automatically report transmission channel restoration to the central station. If service is lost on both transmission channels, transmitter shall initiate the local trouble signal.

D. Digital Data Transmission must include the following at a minimum:
1. Address of alarm-initiating device.
2. Address of supervisory signal.
3. Address of trouble-initiating device.
4. Loss of ac supply, where exceeding programmable time delay.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Local functions and display at the digital alarm communicator transmitter shall include the following:
1. Supervised communications.
2. Programmable
3. Auxiliary relay to indicate alarm or trouble.
4. LED display with audible trouble alarm.
5. Manual test report function and manual transmission clear indication.
6. Communications failure with the central station or fire-alarm control unit.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 SYSTEM ACCESSORIES

A. Magnetic Door Holders: wall or floor mounting and complete with matching doorplate. The door portion shall have a plated steel pivot mounted armature with shock absorbing nylon bearing. Material and finish to match door hardware.

1. Operation: Under normal conditions, the magnets shall attract and hold the door open. Upon activation of the building fire alarm system, the devices shall be de-energized, thus releasing the doors on the circuit.
2. Electromagnets: Require no more than 1 W to develop 35-lbf holding force.
3. Wall-Mounted Units: Flush mounted in a single gang electrical box unless otherwise indicated.
4. Rating: 24-V dc operating on power from the fire alarm control panel.
5. Power source shall be supervised.
6. Door hold open magnets shall be furnished with keepers, door chains, and other accessories as required to properly hold open doors as indicated on the Drawings.
7. Operation: Under normal conditions, the magnets shall attract and hold the door open. Upon activation of the building fire alarm system, the devices shall be de-energized, thus releasing the doors on the circuit.

B. Surge Suppression Devices:

1. AC circuits: UL 1449 listed, 120VAC, 20A branch circuit surge suppressor with EMI filtering. Ditek DTK-DF120S1 or equal. Shunt type devices are not permitted.
2. DC circuits: UL 497B listed, 24VDC, 5A multi stage hybrid design surge suppressor. Ditek DTK-2MHLP or equal. Devices using only MOV active elements are not permitted.

C. Wire Guards: Welded steel wire mesh of size and shape for manual stations, detectors, strobes, or other devices requiring protection.

1. Guard design shall not affect performance of device.
2. Factory fabricated and furnished by manufacturer of device.
3. Finish: Paint of color to match the protected device.

D. Remote Alarm Indicator Lights: Key type switch for testing of the annunciated device.

E. Terminal Cabinets: Steel cabinet with red finish, hinged lift-a-way cover, barrel key lock, terminal identification labels, and listed terminal blocks for up to 120 high barrier termination points. Terminal block screws shall have pressure wire connectors of the self-lifting or box lug type. Provide "FIRE ALARM TERMINAL CABINET" label in permanent lettering on the enclosure cover

F. Documentation Cabinet: Steel cabinet with red finish, hinged cover, barrel key lock, key ring hooks for spare keys, and USB storage device for backup documentation. Sized to accommodate standard 8 1/2 by 11 Operation and Maintenance manuals, As-Built Drawings, Completion Documents, and Inspection and Testing Form required by NFPA 72. Provide "SYSTEM RECORD DOCUMENTS" label in permanent lettering on the enclosure cover.

2.14 FIRE ALARM CONDUCTORS AND CABLE

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

1. Allied Wiring and Cable
2. Belden
3. Comtran Corporation
4. General Cable
5. Honeywell Genesis
6. Radix Wire & Cable
7. Southwire
8. Superior Essex
9. West Penn Wire

B. General Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

1. Type FPLR or FPLP, red jacket, suitable for indoor locations.
2. Type PLTC, suitable for underground or wet locations.
3. Twisted, shielded pair, low capacitance, not less than No. 18 AWG unless recommended otherwise by system manufacturer.
4. Circuit Integrity Cable: Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 EQUIPMENT INSTALLATION

A. All equipment supplied must be specifically listed for its intended use and shall be installed in accordance with the manufacture's recommendations. The contractor shall consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

B. Comply with NECA 305, NFPA 70, NFPA 72, and requirements of AHJ for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

C. Securely fasten all system components to wall and ceiling assemblies using fasteners and supports rated to support the required load in accordance with Section 260500, "Common Work Results for Electrical Systems".

1. Ceiling mounted devices shall not be supported solely by suspended ceilings.

D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above finished floor. Locate annunciators at a height that enables easy viewing.

E. Provide additional remote NAC power supplies as required to comply with voltage drop requirements.

F. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm boxes in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

G. Notification Devices:

1. Comply with NFPA 72 and ADA criteria for strobe visual intensity, audible appliance intelligibility, and final device placement.
2. Install wall devices with entire lens between 80-inches and 96-inches above the floor but not less than 6 inches below the ceiling. Install devices on flush-mounted back boxes with the audible device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

H. End of Line (EOL) Resistors: Label devices containing end-of-line resistors with NAC panel and circuit number in such a manner that removal of the device is not required to identify the EOL device. Locate EOL devices in a readily accessible location no more than 12-feet above finished floor.

I. Smoke and Heat Detectors:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing for smoke detectors shall not exceed 30 feet except in corridors where increased spacing are allowed in accordance with NFPA 72.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from diffusers or return-air openings.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
7. When installed in a room, detectors shall be oriented, so their alarm light is visible from the nearest door to the corridor.
8. Unless suitably protected against dust, paint, etc., spot type smoke detectors shall not be installed until the final construction clean-up has been completed. In the event of contamination during construction, the detectors must be replaced by the contractor at no additional cost to the Owner. Covers supplied with smoke detector heads do not provide protection against heavy construction dust, spray painting, etc., and must not be used for that purpose. They are suitable only during final, minor cleanup or touchup operations.

J. Duct Smoke Detectors:

1. Provide duct smoke detectors for the following locations:
    a. At all smoke dampers.
    b. At all HVAC units (AHUs, OA units, Heat Pump Units, etc) with fans greater than 2,000 CFM.
    c. At each story, prior to the duct connection at a common return, for air distribution systems with a combined capacity greater than 15,000 CFM serving more than one story.
    d. Additional locations required by the Building Code.
2. Comply with NFPA 72, IMC, and NFPA 90A for HVAC unit shutdown and closing of smoke dampers.

3. Install sampling tubes so they extend the full width of duct.
4. Support tubes more than 36 inches long at both ends.
5. Extend the intake tube through the far side of the duct, seal around the tube where it penetrates the duct wall and plug the end with a rubber stopper to facilitate visual inspection and intake tube cleaning.
6. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to final acceptance.
7. Locate duct detectors in a manner that provides suitable, convenient access for required periodic cleaning and calibration.
8. Comply with manufacturer's requirements for clearances from HVAC equipment and duct accessories such as humidifiers.
9. Provide number of detectors per duct in accordance with NFPA 72 requirements based on the size of the air duct, air duct configuration, air speed, and duct manufacturer's installation requirements.
10. Indicate airflow direction on the duct, adjacent to the detector, using stencil or permanent decal.
11. Provide each duct smoke detector with a remote keyed test switch and alarm indicator.

K. HVAC Unit Shutdown

1. Provide control relays for HVAC unit shutdown at the following minimum locations:
   a. For all fans associated with HVAC units (including fan powered VAVs) connected to an air distribution system with a combined capacity greater than 2,000 CFM. Shut down fans upon activation of the associated smoke detector(s).
   b. For all High Velocity Low Speed (HVLS) ceiling fans. Shut down fans upon activation of sprinkler system water flow alarm.
2. Comply with NFPA 72, IMC, and NFPA 90A for supervision and control of HVAC unit shutdown components.
3. All shutdown relays shall be directly controlled and monitored by the fire alarm system. Wire relays for fail safe operation.
4. The Building Automation System (BAS) shall not be used for life safety functions unless the BAS is supervised by the Fire Alarm System for off normal conditions.
5. Provide a supervised "AHU Shutdown Defeat" switch in or adjacent to the FACP with an informative engraved label at the FACP about this function. The switch must cause a system "trouble" indication when it's placed in the off-normal ("Shutdown Defeated") position. This is to provide the owner with a convenient means to temporarily resume HVAC operation in the event an unwanted alarm will not clear, prior to arrival of the fire alarm service technician, or for testing purposes.

L. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position and where specifically indicated. Locate in the nearest corridor or public area and identify with engraved label.

M. Addressable Interface Devices:

1. Addressable interface and control modules (used to monitor all contact type initiating devices) must be in a conditioned space, unless they are tested, listed, and marked for continuous duty across the range of temperatures and humidity expected at their installed location.
2. Sprinkler system supervisory circuits for monitoring valve position, air pressure, water temperature, pump status, etc., must cause distinct audible and visible indications at the FACP.
3. Install interface devices used to initiate emergency control functions no more than 36 inches from the component controlling the emergency control function.

N. Isolation Modules: Provide in the following locations to minimize the impact of wiring faults:
   1. After each 50 initiating devices and control points on the addressable loop, or a lesser number where recommended by the manufacturer.
   2. Near the point any addressable circuit extends outside the building, except for those attached to the building exterior walls and well sheltered by walkways.
   3. For loops covering more than one floor, install isolator at terminal cabinet on each floor with additional isolator[s] on any floor with over 50 addresses.
   4. Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling).

3.3 PATHWAYS AND CONDUCTORS

A. Wiring Methods: Install all fire alarm wiring in metal conduit, minimum 3/4-inch, in accordance with Section 260533, "Raceways and Boxes for Electrical Systems" and manufacturer's recommendations. Conceal raceway, except in unfinished spaces.
   1. Unenclosed wiring methods may be used in accessible ceiling spaces. Where not installed in exposed ceilings.
   2. Install plenum rated cable in environmental air spaces, including plenum ceilings.

B. Provide red finish for fire alarm raceways in assessable areas above ceilings, and exposed unfinished spaces. Match adjacent architectural finish for exposed fire alarm raceways in finished areas with red junction box covers.

C. All junction box covers shall be painted red on both sides to designate use for Fire Alarm conductors. The interior of junction boxes shall not be painted.

D. Where allowed, surface boxes shall be as manufactured by the device manufacturer for the installed device and shall match devices in size.

E. There shall be no splices in the system other than at device terminal blocks, or on terminal blocks in cabinets. "Wire nuts" and crimp splices will not be permitted. All terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.

F. For underground raceways and other wet locations, provide moisture resistant PLTC cable.

G. All fire alarm and communications circuits that are run underground or beyond the building footprint shall be provided with a surge protective device at both ends of the circuit.

H. All circuits leaving the riser on each floor or building zone shall feed through a labeled terminal block in a terminal cabinet accessible from the floor.

I. T-Taps are not permitted for Class B circuits. Locate end of branch devices in a readily accessible location.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
   1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Coordinate connections to electronic access-controlled doors with door hardware specifications and actual door hardware. Provide all connections for release of locking mechanisms in egress paths as required.

C. Verify exact connection requirements to all equipment and devices of other trades with those trades prior to ordering equipment.

D. Make addressable connections with a supervised interface device to controlled or monitored devices and systems. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

3.5 IDENTIFICATION

A. Comply with Section 270553, "Identification for Communications Systems"

1. Identify system components, wiring, cabling, and terminals. Identify all fire alarm circuits at terminal and junction locations.
2. Install a nameplate on each fire alarm panel and power supply to indicate the equipment designation, panelboard and circuit number supplying the fire alarm equipment.
3. Branch circuit overcurrent protective devices powering fire alarm equipment shall be identified as FIRE ALARM CIRCUIT with a red and white engraved label permanently affixed to the equipment.
4. Provide engraved label for each remote alarm indicator.
5. Label all addressable control modules to identify their function.

B. Basic operating instructions shall be framed and permanently mounted at the FACP. (If the owner concurs, they may instead be affixed to the inside of the FACP's door.) In addition, the NFPA 72 "Record of Completion" must either be kept at the FACP, or its location shall be permanently indicated there by an engraved label. All System documentation shall be provided and housed in a Documentation Cabinet at the control panel or other approved location in accordance with NFPA 72.

3.6 GROUNDING

A. Ground FACP and surge protective devices for associated circuits in accordance with Section 260526, "Grounding and Bonding for Electrical Systems".

B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

B. Coordinate all testing in occupied buildings with the owner's representative to minimize the disturbance to the building occupants.

C. Visual Inspections: Conduct prior to testing.

1. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.

2. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.

D. Preliminary Testing

1. Check all wiring for grounds, opens, and shorts, prior to termination at panels and installation of detector heads. The minimum resistance to ground or between any two conductors shall be 10 megohms, as verified with an insulation tester.
2. Ensure all devices and circuits are functioning properly in accordance with manufacturer's requirements.

E. System Acceptance Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

1. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
2. Verify candela settings and test visible appliances for public operating mode in accordance with manufacturer's written instructions.
3. Test all site-specific software functions and provide a detailed report showing the system's operational matrix. Each initiating device shall activate the proper response and system notification.
4. Verify all other system functions, including (where applicable) elevator capture and the control of HVAC systems, door locks, pressurization fans, fire or smoke doors/dampers/shutters, etc.
5. Verify digital communicators are on-line and tested for proper communication to the receiving station.
6. All supervised circuits must also be tested to verify proper supervision.
7. Verify the voltage drop of each NAC circuit by testing and recording the voltage at the origin and at the EOL for each NAC circuit, under battery power only.

F. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances, software modification, or wiring modifications. Such re-testing shall be included as part of the base bid and provided at no additional cost to the Owner.

G. Final Acceptance Test: Complete record drawings and system operation matrix are required prior to scheduling final acceptance test.

1. The owner's representative, monitoring service, and fire department shall be notified before final tests in accordance with local requirements.
2. Operate every device to verify proper operation and correct annunciation.
3. Open signaling line circuits and notification appliance circuits in at least two locations to verify proper supervision.

H. Fire-alarm system will be considered defective if it does not pass tests and inspections.

I. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72. Submit certified results to the AHJ, Owner, Architect, and Engineer.

J. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

B. The manufacturer's authorized representative must instruct the owner's designated employees in operation of the system, and in all required periodic maintenance. A minimum of 8 hours on-site time will be allocated for this purpose. Two copies of a written, bound summary will be provided, for future reference.

C. Training shall cover as minimum the following topics:

1. Preventive maintenance service techniques and schedules, including historical data trending of alarm and trouble records.
2. Overall system concepts, capabilities, and functions. Training shall be in depth, so that the owner shall be able to take any device out of service and return any device to service without need of Manufacturer's approval or assistance.
3. Explanation of all control functions, including training to program and operate the system software.
4. Methods and means of troubleshooting and replacement of all field wiring devices.
5. Methods and procedures for troubleshooting the main fire alarm control panel, including field peripheral devices as to programming, bussing systems, internal panel and unit wiring, circuitry and interconnections.
6. Manuals, drawings, and technical documentation. Actual system software used for training shall be provided in digital form and shall be left with the Owner at the completion of training for the Owner's use in the future.

D. A receipt shall be obtained from the Owner that this has been accomplished, and a copy included in the close-out documents.

END OF SECTION

SECTION 285129

EMERGENCY RESPONDER COMMUNICATION ENHANCEMENT SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

A. Description: This section includes labor, material, and equipment to furnish, install and test a complete and operating In-Building Emergency Responder Communication Enhancement System for the purpose of amplifying and distributing throughout the entire building. The radio signals and frequency bands shall be those in use by the Emergency Responders serving this facility. Signal strength levels and coverage in 90% of all areas each floor and 99% of critical areas in accordance with the Fire Code shall be provided.

B. This specification is a performance-based specification. Final and complete design and layout will be provided by the bidder and submitted as part of the shop drawing process.

1.3 REFERENCES

A. Abbreviations and Acronyms:

1. AHJ: Authority Having Jurisdiction.
2. BDA: Bi-directional amplifier.
3. DAQ: Delivered Audio Quality.
4. EMRES: Emergency Responder Radio Enhancement System.
5. FCC: Federal Communications Commission.
6. RF: Radio Frequency.

1.4 COORDINATION

A. Coordinate system scope and layout requirements, attachment methods, and envelope penetrations with architectural and MEP roof plans, elevations, and sections.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations with Division 07 Section "Roof Accessories."

1.5 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Provide the following.

1. Floor plans and ceiling plans showing accurately scaled components and spatial relationship to associated equipment. Include mounting heights with all equipment labeled.
2. Include equipment locations, routing of the distributed antenna system, cabling, antennas, power connections, splitters, couplers, filters, amplifiers, grounding, lightning protection, fire alarm connections, and routing of all cabling.
3. Include building elevation depicting the location of any outdoor antennas associated with the proposed system. Include height of antenna centerline above building, orientation, and location of all external grounding connections and lightning/surge protection.
4. Include enlarged plan views of Equipment Rooms housing head-end and or other consolidated equipment showing all enclosures required for the system. Indicate emergency power sources, location, and circuit requirements both AC power and battery power. Include calculations for battery run time.
5. Wiring Diagrams: Detailed one-line schematic wiring diagrams of the system and the interconnection wiring.

C. Delegated Design Submittals: Indicate compliance with performance requirements and design criteria listed herein, including analysis data signed and sealed by qualified professional responsible for their preparation.

D. Test and Inspection Reports

1. Include documentation of all testing procedures and findings.

E. Qualification Data: For qualified designer.

F. Closeout Submittals

1. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
   a. Final test results.
   b. Signed product certificates certifying system complies with specified performance requirements.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Five continuous years, minimum, design and manufacture of the systems specified.
2. Manufacturing facilities certified to ISO 9001 International Quality Standard with third-party certification verifying quality assurance in design/development, production, installation, and service.
3. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, maintenance, emergency repairs to equipment, and response times less than eight hours.
4. Employ trained staff that are available 24/7 to provide scheduling support and assist with reporting needs.

B. Installer Qualifications:

1. Manufacturer's authorized representative who is trained and certified by the manufacturer for installation and testing of the specified product.

2. Minimum of five years successful installation experience with Projects of similar size and complexity.
3. Upon request, be able to provide a minimum of three reference accounts at which similar work, both in scope and complexity, have been completed by The Contractor within the last three years.
4. Project Personnel Requirements: Installer must have the following certified full-time employees on staff and assigned to the project:
   a. Designer of system and lead installation personnel shall hold a valid FCC issued general radio operators license and certification of in-building system training issued by a nationally recognized organization, school or a certificate issued by the manufacturer of the equipment being installed.

1.7 WARRANTIES

A. Manufacturer Warranty: Manufacturer agrees to repair or replace specified product, and all of its components that fail in materials or workmanship within 12 months from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. All equipment shall have required FCC approvals.

2.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Delegated Design Criteria:

1. Coordinate with the AHJ to ascertain operating frequencies in use. Include local fire, police, EMS, Sheriff and any state, city or county first responder frequencies as required by the AHJ.
2. Provide equipment compatible with the existing state, county and local Fire/Police communications system utilized by the Public Safety and Emergency Responder agencies.
3. Fully coordinate with all agencies involved and any state, federal or county agencies required and fully comply with requirements of such agencies.
4. Provide an FCC certified and compliant system.
5. Signal strength for the installed system shall be considered to have acceptable coverage when signal strength measurements in 90% of all areas on each floor and 99% in all critical areas as determined by the AHJ of the building meet a minimum signal strength into (downlink) the building of -95dBm and a minimum signal strength out (uplink) of the building of -100dBm when received by the agency's radio system when transmitted from within the building.
6. Provide an antenna distribution system installed to provide in-building amplification for all in use bandwidths tuned to the frequencies utilized. Provide building mounted "donor" antennas for all frequencies. The antennas will feed into a BDA (bi-directional amplifier), one for each band, which will distribute the boosted signal throughout the facility with a distributed antenna system utilizing point source fixed antennas, or other proposed solution by designer.

7. The system will be designed and installed per the requirements of NFPA, Building Code, Fire Code, and FCC.
8. Optional methods of achieving conformance to the code and distributing the signal throughout the building may be submitted.

2.3 MANUFACTURERS

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

1. ADRF.
2. Bird Technologies.
3. Comba.
4. Commscope/Andrew.
5. Comprod.
6. Corning.
7. Dali.
8. Fractal Antenna Systems.
9. G-Wave.
10. Laird Antenna.
11. Motorola.
12. RFS Celwave.

B. Source Limitations: Obtain components through one source who assumes responsibility of system component compatibility.

2.4 SYSTEM COMPONENTS

A. Bi-Directional Amplifier:
1. BDAs shall incorporate appropriate RF filters, firmware/software upgradeable band migration, output level control, degrade performance capabilities, and incremental adjustable gain. BDA gain shall be determined by this contractor and sufficient to increase signal to meet or exceed Code levels throughout the building.
2. BDAs shall be class A channelized amplifiers. Full spectrum or Class B amplifiers shall not be used.

B. Donor Antenna:
1. The "donor" antenna signal level shall provide as much head end gain off system as possible but shall be a minimum of 9dB – 15dB above the source under all operating conditions.
2. Antenna Masts: Wind rated per AASHTO Wind Charts with an additional 10 mph rating and a 1.3 gust factor. Contractor to provide all required supports, mounting hardware, and anchoring required for components per manufacturer's requirements. Coordinate materials with Roofing Manufacturer/Contractor if roof mounted and maintain roof warranty.

C. Power Supply:
1. Power supplies for amplifiers and head end equipment shall be served from two independent reliable sources if available. Emergency 120V Generator power (if available) shall be obtained from a local emergency panel.
2. Amplifiers shall be located as determined by designer or as shown on drawings. It is preferable to be as centrally located as possible and if room permits, in the Main Technology Closet or Electrical Room.

3. Each BDA shall be served by a dedicated 20A branch circuit and breaker with a handle lock on device. The secondary power source shall be a dedicated battery, capable of operating the in-building radio system for at least 12 hours at 100% operation capacity.
4. Battery system shall be self/automatic charging system and contained in an enclosure. All signal booster and battery components shall be contained in a NEMA 4 or 4 X type enclosures per NFPA requirements. All enclosures shall be red in color.

D. All signal boosters shall have FCC certification prior to installation. All signal boosters shall be compatible with both analog and digital communications simultaneously at the time of installation. The AHJ shall provide the maximum acceptable propagation delay standard. Contractor shall coordinate with the AHJ.

E. System Monitoring
1. Provide monitoring of system integrity in accordance with NFPA requirements. Provide monitor modules for each BDA and battery cabinet enclosure, quantity as required.
2. Extend addressable fire alarm loop or if zoned system, provide zone modules and zone wiring to these monitor modules and mount the modules near the BDA enclosures.
3. System and Signal Booster Supervisory Signals shall include the following:
   a. Donor Antenna Malfunction
   b. Signal Components Failure
   c. Active RF Emitting Device Failure
4. Power Supply Supervisory Signals shall include the following for each signal booster:
   a. Loss of Normal AC Power
   b. Failure of Battery Charger
   c. Low-Battery Capacity, Alarming at 70 percent of battery capacity
   d. Integrity of communications link between fire alarm system and ERCES.

F. Annunciator:
1. Provide a dedicated annunciator located next to the BDA enclosures to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each signal booster:
   a. Normal AC Power
   b. Signal booster trouble
   c. Loss of normal AC power

G. Cabling:
1. Coaxial cable bandwidth shall be as required for frequencies used. Verify that any stopbands built into the cable do not block the frequencies used.
2. Unless specified or approved by the Engineer, radiating coaxial cable shall not be used.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with manufacturer's installation requirements. Confirm installation tolerances and other conditions affecting performance.

B. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Wiring Methods: Install all cabling in metal conduit, minimum 3/4-inch, in accordance with Section 260533, "Raceways and Boxes for Electrical Systems" and manufacturer's recommendations. Conceal raceway, except in unfinished spaces.

1. Riser runs shall be routed in 2 hour rated shafts.
2. Horizontal runs shall meet NFPA requirements for Survivability level 1 or 2 as required by code based on building construction and systems.

B. Antennas and cabling shall be kept a minimum of 24" from any high voltage cabling/raceways/bus duct or other EMI producing sources. Coordinate routing with field conditions and other trades.

C. Survey facility for any other RF producing components such as mobile radio or base stations and maintain proper separation of antennas so as to not cause interference. Perform adjustments to power output or antenna locations as required to mitigate interference. Coordinate with Owner.

D. Utilize cable manufacturers stripping and crimping tools.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

F. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, use a calibrated torque tool to achieve that indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

3.3 GROUNDING AND BONDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems".
1. Ground cable shields and equipment per manufacturer's requirements.
2. Provide grounding blocks and surge protection for exterior coaxial cabling.
3. Ground antenna mast in accordance with NEC and manufacturer's requirements.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems".

1. Identify all interior antennas to coincide with schematic diagram inside BDA.
2. Identify all exterior RF Antenna cables outside and inside at their point of entry.
3. Permanently affix schematics of the system within the main BDA enclosure.
4. Affix FCC information as to the license holder, call letters, frequencies in use and other pertinent information on the exterior of the BDA.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

B. Provide written 7-day advance notice of any testing to allow The Engineer and Owner's Representative the option to witness the tests.

C. Visual and Mechanical Inspections

1. Inspect connectors for correct pin depth and torque, weatherproofing and damage from minimum bending radius, crushed or deformed cable.
2. Document and label donor antenna(s) physical location(s), cable type and cable length.
3. Ensure all cables are securely captivated with an approved clamp or strap and that the outer jacket has not been compromised from over tightening.
4. Verify all interior antennas have an identifying number visible from the traffic path location.
5. Check NEMA Box enclosure and filters for proper ventilation.
6. Confirm/Verify that the antenna(s) BDA(s) and applicable AC/DC power source are installed to R56 standards and working clearances.

D. Electrical Tests

1. Confirm proper antenna orientation via signal strength test. Coordinate with system municipality the closest and/or strongest tower/signal source to orientate to.
2. Sweep donor antenna(s) using a calibrated FTDR for Return Loss and Distance to Fault.
3. Measure and record donor antenna grounding hardware and ground resistance for adherence to manufacturer or R56 specifications utilizing a megger documenting reading(s) and exact location(s).
4. Measure and record received signal strength of all applicable frequencies at input.
5. Verify BDA amplified power output with spectrum analyzer in both directions from RF in/out.
6. Test amplifiers for proper gain output and signal level.
7. Check spectral purity of amplified signal for harmonics, spurs, and distortion in both directions.
8. Perform an over the air sweep test for excessive harmonic content, spurs, and distortion.
9. Sweep entire cable plant of each frequency band utilizing a FTDR for Return Loss and Distance to Fault from BDA out to building.
10. Cabling and connectors shall be tested with a FTDR Meter for continuity and signal levels for RF power. Testing shall be for input and output paths.
11. Check and log AC input voltages and document circuit number, breaker, and physical location for both the BDA and AC/DC supply.
12. Test battery output under load for 1 hour for proper output. Test charging circuitry for proper performance.

E. Acceptance Tests

1. The radio frequencies used by the ER shall be tested to ensure two-way coverage on each floor of the building to ensure the following:
   a. Measurements in 95 percent of all areas on each floor of the building shall meet the following signal strengths:
      1) Minimum signal strength into the building shall be -95 dBm.
      2) Minimum signal strength out of the building shall be -95 dBm.
   b. Critical areas such as fire command centers, fire pump rooms, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by the AHJ, shall be provided with 99 percent floor area radio coverage.
2. RF Signal Strength Testing
   a. The signal strength test shall be conducted using a calibrated (within last 12 months) spectrum analyzer utilizing antennas similar in use by the emergency responders.
   b. Where signal strength out of the building cannot be efficiently measured, a DAQ Test shall be conducted using a calibrated portable radio of the latest brand and model used by the agency talking through the agency's radio communications system.
   c. Each floor of the building shall be divided into a grid of 20 approximately equal test areas.

d. A test location approximately in the center of each test area shall be selected for the test, with the radio enabled to verify two-way communications to and from the outside of the building through the public agency's radio communications system. Once the test location has been selected, that location shall represent the entire test area. Failure in the selected test location shall be considered failure of that test area. Additional test locations shall not be permitted.
e. Measurements shall be made with the antenna held in a vertical position at three (3) to four (4) feet above the floor to simulate portable radios worn on the belt or turnout coat pocket.
f. A maximum of one (1) (or 5 percent) of nonadjacent test areas shall be allowed to fail the test per floor.
g. In the event that two or more (or > 5 percent) of the test areas fail the test, in order to be more statistically accurate, the floor shall be permitted to be divided into 40 equal test areas. Failure of more than two (or 5 percent) nonadjacent test areas shall result in failure of the test. If the building fails the 40 area test, the building shall be deemed in non-conformance to Code. The facility shall be equipped with an in-building RF amplification antenna system to meet a 90 percent coverage requirement per floor and retested.
h. The gain values of all amplifiers shall be measured, and the test measurement results shall be kept on file with the building Owner so that the measurements can be verified during annual tests.

3. Voice Signal Quality Testing
   a. For quality purposes, DAQ readings shall be taken at the same time as the above RF signal strength measurements. The DAQ scale is as follows:
      1) DAQ 1: Unusable. Speech present but not understandable.
      2) DAQ 2: Speech understandable with considerable effort. Requires frequent repetition due to noise or distortion.
      3) DAQ 3: Speech understandable with slight effort. Requires occasional repetition due to noise or distortion.
      4) DAQ 3.4: Speech understandable without repetition. Some noise or distortion present.
      5) DAQ 4: Speech easily understandable; little noise or distortion.
      6) DAQ 4.5: Speech easily understandable; rare noise or distortion.
      7) DAQ 5: Perfect; no distortion or noise discernible
   b. A DAQ level of 3 or better throughout the building shall be deemed acceptable and passing. Areas not achieving this level shall be deemed as failing.
4. Test Fire Alarm Supervisory and Trouble Signals in accordance with NFPA 72 and project fire alarm specifications. Verify proper annunciation.

F. Test and Inspection Reports: Prepare a written report to certify compliance with test parameters and record the following:

1. Test procedures used.
2. Date, time, and weather conditions during testing.
3. Results that comply with requirements.
4. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
5. Prepare information in a format required by the AHJ.

G. Products will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Completion, provide on-site assistance in adjusting antennas to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Provide 4 hours of system training and maintenance instruction to Owner's personnel. Record training and submit DVD with O&M.

END OF SECTION 28 51 29

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SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. The following practices are prohibited within protection zones:
   1. Revise subparagraphs below to suit Project.
   2. Storage of construction materials, debris, or excavated material.
   3. Parking vehicles or equipment.
   4. Foot traffic.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

C. Do not direct vehicle or equipment exhaust towards protection zones.

D. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

E. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   1. Grind down stumps and remove roots, obstructions, and debris to a depth of 24 inches below exposed subgrade.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
   1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 31 20 00
EARTH MOVING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Preparing subgrades for walks pavements turf and grasses and plants.
   2. Excavating and backfilling for buildings and structures.
   3. Drainage course for concrete slabs-on-grade.
   4. Subbase course for concrete walks pavements.
   5. Subbase course and base course for asphalt paving.
   6. Subsurface drainage backfill for walls and trenches.
   7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:
   1. for excavating well hole to accommodate elevator-cylinder assembly.
   2. Section 311000 "Site Clearing" for site stripping, grubbing, stripping topsoil, and removal of above- and below-grade improvements and utilities.
   3. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
   4. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom; measured according to SAE J-1179.
2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

M. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

1.5 RETAIN ONE OR BOTH OF FIRST TWO PARAGRAPHS BELOW IF EXPLOSIVES ARE PERMITTED. RETAIN SECOND PARAGRAPH ONLY IF SEISMIC SURVEY IS REQUIRED WITH BLASTING.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
   1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before beginning earth moving operations.

D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Section 311000 "Site Clearing," are in place.

E. Do not commence earth moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

F. The following practices are prohibited within protection zones:
   1. Revise subparagraphs below to suit Project.
   2. Storage of construction materials, debris, or excavated material.
   3. Parking vehicles or equipment.
   4. Foot traffic.
   5. Erection of sheds or structures.
   6. Impoundment of water.
   7. Excavation or other digging unless otherwise indicated.
   8. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

C. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

D. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

G. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

I. Sand: ASTM C 33; fine aggregate.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
   1. Red: Electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
   1. Red: Electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
   1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
   2. Retain first subparagraph below if required.
   3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:
   1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
   1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
   1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:
   1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
   3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
   1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
   2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
   1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.

C. Trenches under Roadways: Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course.

3.11 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
   3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
   4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.14 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch.
   2. Walks: Plus or minus 1 inch.
   3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.15 SUBSURFACE DRAINAGE

A. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
   1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.
   2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.16 CUT AND FILL CALCULATIONS - CONTRACTOR'S RESPONSIBILITY

A. It is the Contractor's responsibility to fully calculate all earthwork to determine requirements for earthwork construction prior to Bid submission in accordance with the Contract Documents. There will be no change orders issued for hauling soil offsite or onto the site as necessary to meet the final grades and the requirements of the Project Master Schedule.
   1. If there is an excess of soil after Construction is complete, the Contractor shall include in their Bid the costs to haul all excess soil off the Owner's property at no additional costs to the Owner. Excess soil from all sources, such as, but not limited to, foundation excavation, utility trenches, etc., shall be included in the calculations.
   2. If additional soil is needed to meet indicated grade elevations, the Contractor shall include in their Bid all costs associated with buying and hauling the extra soil needed to the site at no additional costs to the Owner.
   3. Temporary stockpile locations are indicated on the Drawings, however, these are only available during Construction and all excess soil, including topsoil, if applicable, shall be removed.

3.17 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
   1. Place base course material over subbase course under hot-mix asphalt pavement.
   2. Shape subbase course and base course to required crown elevations and cross-slope grades.
   3. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
   4. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   5. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.18 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   1. Place drainage course 6 inches or less in compacted thickness in a single layer.
   2. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   3. Compact each layer of drainage course to required cross sections and thicknesses to not less than **95** percent of maximum dry unit weight according to ASTM D 698.

3.19 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   2. Determine that fill material and maximum lift thickness comply with requirements.

3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
4. Insert special inspections.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Cold milling of existing hot-mix asphalt pavement.
   2. Hot-mix asphalt patching.
   3. Hot-mix asphalt paving.
   4. Hot-mix asphalt paving overlay.
   5. Asphalt surface treatments.
   6. Pavement-marking paint.

B. Related Sections:
   1. Division 32 Sections for other paving installed as part of crosswalks in asphalt pavement areas.

1.3 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located INDOT.

B. Installer Qualifications: Imprinted-asphalt manufacturer's authorized installer who is trained and approved for installation of imprinted asphalt required for this Project.

C. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

D. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of INDOT for asphalt paving work.
   1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
   1. Prime Coat: Minimum surface temperature of 60 deg F.
   2. Tack Coat: Minimum surface temperature of 60 deg F.
   3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
   4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
   5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, and not exceeding 95 deg F.

PART 2 PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
   1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22 .

B. Asphalt Cement: ASTM D 3381 for viscosity-graded material.

C. Prime Coat: Asphalt emulsion prime coat complying with INDOT requirements.

D. Tack Coat: emulsified asphalt, or cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

E. Water: Potable.

F. Undersealing Asphalt: ASTM D 3141, pumping consistency.

2.3 AUXILIARY MATERIALS

A. Sand: ASTM D 1073, Grade Nos. 2 or 3.

B. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N; colors complying with FS TT-P-1952.

C. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
   1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
   2. Base Course: 1 inch.
   3. Surface Course: 1/2 inch.

B. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."
   1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
   2. Provide mixes complying with composition, grading, and tolerance requirements in ASTM D 3515 for the following nominal, maximum aggregate sizes:
      a. Base Course: 1 inch.
      b. Surface Course: 1/2 inch.

C. Emulsified-Asphalt Slurry: ASTM D 3910, Type 1.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
   1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
   2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
   3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.

2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 250 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.3 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints as shown on Drawings.
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.4 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.5 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
   1. Base Course: 1/4 inch Insert size.
   2. Surface Course: 1/8 inch.
   3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.6 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
   1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.7 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
   1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
   2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
      a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
      b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
   1. Do not allow milled materials to accumulate on-site.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:
   1. Driveways and roadways.
   2. Walkways.

B. Related Sections include the following:
   1. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.
   2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.

1.3 DEFINITIONS

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

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

1.5 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
   1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
   1. Portland Cement: ASTM C 150, Type I I/II, gray. Supplement with the following:
      a. Fly Ash: ASTM C 618, Class C.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.
   1. Maximum Coarse-Aggregate Size: 1 inch nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

2.4 CURING MATERIALS

A. Water: Potable.

2.5 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
   1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:
   1. Compressive Strength (28 Days): 4500 psi.
   2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
   3. Slump Limit: 5 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
   2. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

3. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.
1. Fly Ash or Pozzolan: 25 percent.

2.6 SEALER

A. Excluding Unit Pavers, apply a heavy body sealer per manufacturer's requirements. The concrete sealer shall be an odor-free water-based, non-toxic, non-acid concrete cleaner and sealer.
1. Products:
a. Smith's Permanent Concrete Sealer.
b. Surface Koatings, Surface WB-75.
c. Specco, Waterstopper S-10.
d. CreteDegender.
e. Approved equal.

2.7 CONTROL JOINTS

A. Submit control joint location drawing prior to cutting and placing control joints for review and approval.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."

C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Do not add water to concrete during delivery or at Project site.

E. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer or use bonding agent if approved by Architect.

I. Screed pavement surfaces with a straightedge and strike off.

J. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

K. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

L. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.
1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

M. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

N. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

O. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Revise number of laboratory- or field-cured test specimens below if required.
6. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
7. Coordinate number of compression test specimens in subparagraph above with number of compressive-strength tests in subparagraph and associated subparagraph below.
8. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 13 73
CONCRETE PAVING JOINT SEALANTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Cold-applied joint sealants.

B. Related Sections:
   1. Division 07 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.
   2. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
   3. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

1.4 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.

1. Products: Subject to compliance with requirements, provide the following:
   a. Crafco Inc., an ERGON company; RoadSaver Silicone.
   b. Dow Corning Corporation; 888.
   c. Pecora Corporation; 301 NS.

2.3 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.4 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of joint-sealant backings.

2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place joint sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
1. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

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

3.5 PROTECTION

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

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Seeding.
   2. Hydroseeding.
   3. Sodding.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

PART 2 PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:
1. Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.
2. Quality, Non-State Certified: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
3. Sun and Partial Shade, Cool-Season Grass: Proportioned by weight as follows:
   a. 50 percent Kentucky bluegrass (Poa pratensis).
   b. 30 percent chewings red fescue (Festuca rubra variety).
   c. 10 percent perennial ryegrass (Lolium perenne).
   d. 10 percent redtop (Agrostis alba).

2.2 TURFGRASS SOD

A. Turfgrass Sod: complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

B. Turfgrass Species, Cool-Season Grass: Sod of grass species as follows, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
1. Sun and Partial Shade: Proportioned by weight as follows:
   a. 50 percent Kentucky bluegrass (Poa pratensis).
   b. 30 percent chewings red fescue (Festuca rubra variety).
   c. 10 percent perennial ryegrass (Lolium perenne).
   d. 10 percent redtop (Agrostis alba).

2.3 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition:
   a. 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
   b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition:
      a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
      b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
   2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 TURF AREA PREPARATION

A. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

B. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.3 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
   1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   2. Do not use wet seed or seed that is moldy or otherwise damaged.
   3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 2 lb/1000 sq. ft.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

3.4 SODDING

A. Lay sod within 24 hours of harvesting unless a suitable preservation method is accepted by Architect prior to delivery time. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   1. Lay sod across slopes exceeding 1:3.
   2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.5 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

3.6 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations.

Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.7 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION

SECTION 33 41 00
STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Cleanouts.
   3. Manholes.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.4 ACTION SUBMITTALS

A. Product Data with Shop Drawings:
   1. Product Data: For each type of product indicated.
   2. Shop Drawings:
      a. Manholes: Include plans, elevations, sections, details, frames, and covers.
      b. Include plans, elevations, sections, details, frames, covers, and grates.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

B. Handle manholes according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of service without Architect's written permission.

PART 2 PRODUCTS

2.1 MANHOLES

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
9. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:
1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
   2. Install piping with 36-inch minimum cover.

3.3 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.4 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.5 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
      a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.

b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
   a. Unshielded flexible couplings for same or minor difference OD pipes.
   b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
   c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
2. Use pressure-type pipe couplings for force-main joints.

3.6 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch-thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Division 31 Section "Earth Moving."

END OF SECTION