

Project Manual

Vaughn Public Library Building Renovation

502 West Main Street
Ashland, Wisconsin 54806

SECTION 00 01 10
TABLE OF CONTENTS

PROCUREMENT AND CONTRACTING REQUIREMENTS

1.01 DIVISION 00 -- PROCUREMENT AND CONTRACTING REQUIREMENTS

- A 00 01 10 - Table of Contents
- B 00 11 13 - Advertisement for Bids
- C 00 21 13 - Instructions to Bidders
- D 00 41 13 - Bid Form
- E 00 45 13 - Qualification Statement
- F 00 52 13 - Form of Agreement
- G 00 72 13 - General Conditions
- H 00 73 00 - Supplementary Conditions
- I 00 73 13 - Performance and Payment Bond Requirements
- J 00 73 16 - Insurance Requirements

SPECIFICATIONS

2.01 DIVISION 01 -- GENERAL REQUIREMENTS

- A 01 10 00 - Summary
- B 01 23 00 - Alternates
- C 01 26 00 - Contract Modification Procedures
- D 01 29 00 - Payment Procedures
- E 00 31 00 - Project Management and Coordination
- F 01 32 00 - Construction Progress Documentation
- G 01 32 10 - Project Schedule
- H 01 33 00 - Submittal Procedures
- I 01 40 00 - Quality Requirements
- J 01 50 00 - Temporary Facilities
- K 01 60 00 - Product Requirements
- L 01 73 00 - Execution
- M 01 74 19 - Construction Waste Management and Disposal
- N 01 77 00 - Closeout Procedures
- O 01 78 23 - Operations and Maintenance Data
- P 01 78 39 - Project Record Documents

2.02 DIVISION 02 -- EXISTING CONDITIONS

- A 02 41 00 – Demolition
- B 02 41 13 – Site Demolition

2.03 DIVISION 03 -- CONCRETE

- A NOT USED

2.04 DIVISION 04 -- MASONRY

- A 04 01 40.62 - Brick Masonry and Repointing
- B 04 22 00 - Concrete Masonry Unit

2.05 DIVISION 05 -- METALS

- A 05 12 00 - Structural Steel Framing

B 05 40 00 - Cold-Formed Metal Framing

C 05 73 00 - Decorative Metal Railings

2.06 DIVISION 06 -- WOOD, PLASTICS, AND COMPOSITES

A 06 10 00 - Rough Carpentry

B 06 16 00 - Sheathing

C 06 20 00 - Finish Carpentry

D 06 41 00 - Architectural Wood Casework

2.07 DIVISION 07 -- THERMAL AND MOISTURE PROTECTION

A 07 14 16 – Cold Fluid-Applied Waterproofing

B 07 54 00 - Thermoplastic Membrane Roofing

C 07 72 00 - Roof Accessories

D 07 84 00 - Firestopping

E 07 92 00 - Joint Sealants

2.08 DIVISION 08 -- OPENINGS

A 08 11 13 - Hollow Metal Doors and Frames

B 08 14 16 - Flush Wood Doors

C 08 32 10 - Custom Sliding Gate and Fixed Screens

D 08 52 00 - Wood Windows

E 08 71 00 - Door Hardware

F 08 80 00 - Glazing

2.09 DIVISION 09 -- FINISHES

A 09 21 16 - Gypsum Board Assemblies

B 09 63 40 - Stone Flooring

C 09 65 00 - Resilient Flooring

D 09 68 13 - Tile Carpeting

E 09 72 00 - Wall Coverings

F 09 84 30 – Sound-Absorbing Wall Units

G 09 91 23 - Interior Painting

H 09 93 00 - Staining and Transparent Finishing

2.10 DIVISION 10 -- SPECIALTIES

A 10 14 00 - Applied Vinyl Letter Signage

B 10 14 19 - Dimensional Letter Signage

C 10 14 23 - Panel Signage

D 10 2601 - Wall and Corner Protection

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

F 10 31 00 - Manufactured Fireplaces

G 10 44 00 - Fire Protection Specialties

2.11 DIVISION 11 -- EQUIPMENT

A 11 30 13 - Residential Appliances

B 11 51 16 - Library Specialties

2.12 DIVISION 12 -- FURNISHINGS

A 12 24 00 - Window Shades

B 12 36 00 - Countertops

2.13 DIVISION 13 -- SPECIAL CONSTRUCTION

A NOT USED

2.14 DIVISION 14 -- CONVEYING EQUIPMENT

A NOT USED

2.15 DIVISION 21 -- FIRE SUPPRESSION

A 21 05 00 – Common Work Results for Fire Suppression

B 21 05 29 – Hangers and Supports for Fire Suppression Piping and Equipment

C 21 10 00 – Water-Based Fire-Suppression Systems

2.16 DIVISION 22 -- PLUMBING

A 22 05 00 – Common Work Results for Plumbing

B 22 05 14 – Plumbing Specialties

C 22 05 15 – Piping Specialties

D 22 05 23 – General Duty Valves for Plumbing Piping

E 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

F 22 07 00 – Plumbing Insulation

G 22 10 13 – Facility Fuel Piping

H 22 11 00 – Facility Water Distribution

I 22 13 00 – Facility Sanitary Sewerage

J 22 30 00 – Plumbing Equipment

K 22 42 00 – Commercial Plumbing Fixtures

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

A 23 05 00 – Common Work Results for HVAC

B 23 05 02 – Mechanical Demolition and Alterations

C 23 05 13 – Common Motor Requirements for HVAC Equipment

D 23 05 14 – Variable Frequency Drives

E 23 05 15 – Piping Specialties

F 23 05 23 – General-Duty Valves for HVAC Piping

G 23 05 29 – Hangers and Supports for HVAC Piping and Equipment

H 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment

I 23 05 93 – Testing, Adjusting, and Balancing for HVAC

J 23 07 00 – HVAC Insulation

K 23 29 13 – Instrumentation and Control Devices for HVAC

L 23 09 23 – Direct Digital Control System for HVAC

M 23 09 93 – Sequence of Operation for HVAC Controls

N 23 21 13 – Hydronic Piping

O 23 21 23 – Hydronic Pumps

P 23 23 00 – Refrigerant Piping

Q 23 25 00 – HVAC Water Treatment

R 23 31 00 – HVAC Ducts and Casings

S 23 33 00 – Air Duct Accessories

- T 23 34 00 – HVAC Fans
- U 23 36 00 – Air Terminal Units
- V 23 37 13 – Diffusers, Registers, and Grilles
- W 23 41 00 – Particulate Air Filtration
- X 23 52 00 – Heating Boilers
- Y 23 62 13 – Packaged Air-Cooled Refrigerant Compressor and Condensing Units
- Z 23 73 12 – Air Handling Unit Coils
- AA 23 73 13 – Modular Indoor Central-Station Air-Handling Units
- BB 23 82 00 – Heating and Cooling Terminal Units

2.18 DIVISION 25 -- INTEGRATED AUTOMATION

- A NOT USED

2.19 DIVISION 26 -- ELECTRICAL

- A 26 00 10 – Supplemental Requirements for Electrical
- B 26 00 11 – Selective Electrical Demolition
- C 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
- D 26 05 26 – Grounding and Bonding for Electrical Systems
- E 26 05 29 – Hangers and Supports for Electrical Systems
- F 26 05 33.13 – Conduits for Electrical Systems
- G 26 05 33.16 – Boxes and Covers for Electrical Systems
- H 26 05 44 – Sleeves and Sleeve Seals for Electrical Raceways and Cabling
- I 26 05 53 – Identification for Electrical Systems
- J 26 05 73.13 – Short-Circuit Studies
- K 26 05 73.16 – Coordination Studies
- L 26 05 73.19 – Arc-Flash Hazard Analysis
- M 26 09 23 – Lighting Control Devices
- N 26 24 13 – Switchboards
- O 26 24 16 – Panelboards
- P 26 27 13 – Electricity Metering
- Q 26 27 26 – Wiring Devices
- R 26 28 13 – Fuses
- S 26 50 00 - Lighting

2.20 DIVISION 27 -- COMMUNICATIONS

- A 27 05 26 – Grounding and Bonding for Communications Systems
- B 27 05 28 – Pathways for Communications Systems
- C 27 05 29 – Hangers and Supports for Communications Systems
- D 27 05 53 – Identification for Communications Systems
- E 27 11 00 – Communications Equipment Room Fittings
- F 27 13 23 – Communications Optical Fiber Backbone Cabling
- G 27 15 13 – Communications Copper Horizontal Cabling

2.21 DIVISION 28 -- ELECTRONIC SAFETY AND SECURITY

- A 28 46 21.11 – Addressable Fire-Alarm Systems

2.22 DIVISION 31 -- EARTHWORK

- A 31 00 10 – General Provisions for Civil Work
- B 31 23 00 – Excavations and Embankments
- C 31 25 00 – Environmental and Sedimentation Controls
- D 31 32 19 – Geosynthetic Stabilization, Separations, and Drainage Fabrics

2.23 DIVISION 32 -- EXTERIOR IMPROVEMENTS

- A 32 11 16 – Subbase Courses
- B 32 11 23 – Aggregate Base Courses
- C 32 12 16 – Asphalt Paving
- D 32 16 00 – Curbs, Gutters, Sidewalks, and Driveways
- E 32 17 23 – Pavement Markings
- F 32 17 26 – Detectable Warning Field

2.24 DIVISION 33 -- UTILITIES

- A 33 05 13 – Manholes and Structures
- B 33 40 00 – Stormwater Utilities

2.25 DIVISION 34 -- TRANSPORTATION

- A 34 71 13 – Vehicle Barriers – Traffic Control

2.26 DIVISION 40 -- PROCESS INTEGRATION

- A NOT USED

2.27 DIVISION 46 -- WATER AND WASTEWATER EQUIPMENT

- A NOT USED

**SECTION 001113
ADVERTISEMENT FOR BIDS**

VAUGHN PUBLIC LIBRARY

RENOVATION

1.1 NOTICE

- A. The City of Ashland, hereafter referred to as the Owner, hereby gives notice of the taking of Bids for the renovation of the Vaughn Public Library, hereafter known as the Project.

1.2 QUALIFICATION STATEMENTS

- A. Contractor's Qualification Statement, AIA A305 (or Section 004513) must be completed by all bidders and submitted along with the Bid Form.

1.3 PROJECT DESCRIPTION

- A. The project consists of exterior repairs and interior renovation of the existing library. Work will include foundation waterproofing, window replacement, masonry tuckpointing, selective demolition, partitions, frames, doors, millwork and interior finishes. The existing mechanical, plumbing and electrical systems will be replaced. A new fire protection system will be added throughout. Sitework will include sections of new sidewalk construction.

1.4 DOCUMENTS

- A. All Bids shall be based on Drawings and Project Manual prepared by Engberg Anderson, Inc. and dated November 26, 2024.
- B. Bid documents will be available as PDF files on **November 26th** through:
1. **Quest Construction Data Network**
 2. **Project #: 9422103**
 3. Owner #: 233682
 4. Website: questcdn.com
 5. Phone: 1 (952) 233-1632

1.5 PRE-BID CONFERENCE AND SITE VISITS

- A. A Hybrid Pre-Bid conference will be conducted on Wednesday, **December 11th**, at 1:00 p.m. prevailing local time, at the 2nd floor Library Meeting Room and via Zoom.
- B. An optional building tour led by the Library Director will be held on December 11th immediately following the Pre-Bid conference.

1.6 DELIVERY OF BIDS

- A. Bids are due;
1. Deliver to the office of the Library Director,
 - a. Vaughn Public Library, 502 Main St W, Ashland, WI 54806
 2. Bids will be received on Tuesday, **January 7th** until 2:00 p.m. prevailing local time.
 3. Bids will be opened publicly at 2:05 p.m. local prevailing time in the Library Meeting Room.

1.7 FORM OF BID

- A. All bids must be placed in a sealed envelope, clearly labeled on the lower left-hand corner with the words "SEALED BID – LIBRARY RENOVATION"
- B. Provide two (2) copies of the bid form.
- C. Bidders must provide a cashiers check or a bid bond in the amount of 5% of the gross amount of the total bid, including alternates, with their bid form. Bidders must also include contractor qualification statements with their bid.
- D. The Bidder will certify compliance with Wisconsin statutes governing Tax Exemptions.
- E. No bid can be withdrawn or modified after the time set for receipt of bids and pending consideration of the action upon same by the Owner. In no event will action upon bids be deferred beyond 60 days from the time set for receipt of bids.
- F. The ability of the apparent low bidder(s) to successfully execute the Work in accordance with the contract documents and on time will be considered by the Owner in making an award.
- G. The Owner reserves the right to reject any and all bids and waive any technicalities therein.
- H. The Owner is not responsible for any costs associated with the preparation of bids in response to this solicitation.

1.8 AUTHORITY

- A. Published upon order of the City of Ashland.

END OF SECTION 00 11 13

SECTION 00 21 13 INSTRUCTIONS TO BIDDERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes.
 - 1. Definitions
 - 2. Bidding Contact Information
 - 3. Bidding Documents
 - 4. Pre-Bid Conference
 - 5. Interpretation of Bid Documents and Addenda
 - 6. Substitutions
 - 7. Bidding Procedures
 - a. Alternate Bids
 - 8. Bid Bond
 - 9. Bid Attachments
 - 10. Bidders Representations
 - 11. Receipt and Opening of Bids
 - 12. Consideration of Bids
 - 13. Post-Bid Information
 - a. Performance Bond and Payment Bond

- B. Related Sections
 - 1. Section 00 11 13 – Advertisement For Bids:
 - a. Date, Time and Location of Pre-Bid Conference.
 - b. Date, Time and Location for receipt of Bids.
 - c. Summary of Bidding terms.
 - 2. Section 00 45 13 – Qualification of Bidders:
 - a. Requirements to be met by all parties interested in submitting a Bid.
 - 3. Section 00 72 13 – General Conditions: Contract requirements.

1.2 DEFINITIONS

- A. The Bid Documents include the following:
 - 1. Bid Requirements:
 - a. Advertisement to Bid, Section 00 11 13
 - b. Qualification of Bidders, Section 00 45 13
 - c. The Bid Form, Section 00 41 13
 - d. Certificates of Insurance, Section 00 73 16 Insurance Requirements
 - 2. Proposed Contract Documents:
 - a. Section 00 52 13 - Form of Agreement between Owner and Contractor, AIA A101.
 - b. Section 00 72 13 - General Conditions of the Contract, AIA A201.
 - c. Section 00 73 00 - Supplementary Conditions of the Contract.
 - d. Section 00 73 13 - Performance & Payment Bond Requirements.
 - e. Section 00 73 16 - Insurance Requirements.
 - f. Drawings
 - g. Project Manual
 - h. Addenda issued prior to the execution of the Contract

- B. General definitions set forth in the General Conditions of the Contract for Construction, AIA A201 2017, are applicable to the Bid Documents.
- C. Other definitions
 - 1. Addenda are written or graphic instruments used by the Architect prior to the execution of the Contract which modify or interpret the Bid Documents by addition, deletion, clarification, or correction.
 - 2. A Bid is a complete and properly signed proposal to the Work for the sums stipulated therein, submitted in accordance with the Bid Documents.
 - 3. The Base Bid is the sum stated in the Bid for which the Bidder offers to perform the Work described in the Bid Documents as the base, to which Work may be added or from which work may be deleted for sums stated in Alternate Bids.
 - 4. An Alternate Bid is an amount stated in the Bid to be added or deleted from the sum of the Base Bid if the corresponding Work, as described in the Bidding Documents, is made part of the project.
 - 5. A Bidder is a person or entity who submits a Bid.
 - 6. A Unit Price is an amount stated in the Bid as a price per unit of measure for materials, equipment, or services or portion of the Work as described in the Bid Documents.

1.3 BIDDING CONTACT INFORMATION

- A. Questions relating to the Bid Documents should be emailed to:
 - 1. Joselia Mendiola
 - 2. joseliam@engberganderson.com - E-mail

1.4 BIDDING DOCUMENTS

- A. Bid Documents are available in accordance with the Advertisement for Bids, Section 00 11 13.
- B. Bid Documents will be issued directly to sub-bidders.
- C. Bidders shall use complete sets of Bid Documents in preparing Bids.
- D. The Bid Documents are available for the sole purpose of obtaining Bids on the Work. The Owner and Architect do not confer license or grant permission for any other use of the Bid Documents.

1.5 PRE-BID CONFERENCE

- A. See Section 00 11 13 for Date, Time and Location of Pre-Bid Conference.

1.6 INTERPRETATION OF BID DOCUMENTS

- A. Bidders shall promptly notify the Architect of any ambiguity, inconsistency, or error, which they may discover upon examination of the Bid Documents, site, or local conditions.
- B. Bidders requiring clarification or interpretation of the Bid Documents shall make a request to the Architect no later than 11 calendar days prior to the date on which bids are due.
 - 1. All requests shall be in written form transmitted by email.
 - 2. All responses shall be in a written format, available for all bidders and published with the final Addenda.
- C. No oral interpretation of the Bid Documents will be made.
- D. Clarification to all Bidders shall be by Addendum, issued no later than 7 calendar days prior to the date on which bids are due.

- E. In the event that conflicts exist within the bid documents, Bidders shall include in their bid the item(s) of higher value and/or quantity or the most restrictive method on installation. The Architect shall provide final interpretation and directions after Contract award.
- F. Receipt of Addenda must be acknowledged by the Bidder on the Bid Form. All Addenda so issued shall become part of the Bid and Contract Documents.

1.7 SUBSTITUTIONS PRIOR TO BIDDING

- A. Materials, products, and equipment described in the Bid Documents establish a standard of required function, dimension, appearance, and quality to be met by any proposed substitution.
- B. Request for Substitution shall be submitted to the Architect no later than 10 calendar days prior to the date on which bids are due.
- C. Approvals, if granted, shall appear in the Addendum issued no later than 7 calendar days prior to the date on which bids are due.
- D. Request for Substitutions shall include the following:
 - 1. Use of Substitution Request Form provided in Section 01 60 00-7 "Product Requirements"
 - 2. Adherence to requirements called out in Section 01 60 00 "Product Requirements", including but not limited to:
 - a. Name of material or equipment originally specified.
 - b. Description of proposed substitution including:
 - 1) Drawings.
 - 2) Side by side analysis of Performance or test data against the specified product.
 - 3) Other relevant data.
 - c. Description of changes in other materials or equipment or other portions of the Work, including that of other contracts, made necessary by the incorporation of the substitution.
 - 3. Incomplete Requests will be Rejected without consideration.
- E. Burden of proof of merit of the proposed substitution is on the proposer.
- F. The Architect's decision of approval or disapproval is final.

1.8 BIDDING PROCEDURES

- A. Bids shall be submitted on forms identical to that included in the Bid Documents, Section 00 41 13.
 - 1. All copies of the Bid, Bid Security, and any other documents required shall be submitted in a sealed opaque envelope.
 - a. Within the bid submittal envelope, the Contractor may include a separate sealed envelope labelled, "TRADE SECRETS – PROPRIETARY CONFIDENTIAL INFORMATION" and place within it any bid components that meet this criteria, including the Qualification Statement.
 - b. The Bid Form may not be included as a Trade Secret.
 - 2. The envelope shall be identified with the Bidder's name, address, and portion of the Work being bid.
 - 3. 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.
- B. All blanks on the form shall be filled in by text or printed manually in ink.
- C. Where indicated, sums shall be expressed in both words and figures. In the case of discrepancy between the two, the amount written in words shall govern.
 - 1. The amounts entered on the Bid Form shall reflect the Owner's Tax Status.
- D. Alterations and erasures must be initialed by the signatory of the Bid.

- E. Alternate Bids
 - 1. All requested Alternates shall be bid. If no change in the Base Bid sum is required, enter "No Change".
 - 2. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option.
 - 3. Indicate in the space provided on the Bid Form the change to the amount bid for base bid construction for the following alternate bids.
 - 4. Schedule of Alternates:
 - a. See Section 01 23 00 - Alternates.
- F. No stipulations or qualification shall be allowed.
- G. Each copy of the Bid Form shall include the legal name of the Bidder and a statement that the Bidder is a sole proprietor, partnership, corporation, or other legal entity.
- H. Each copy shall be signed by the person(s) legally authorized to bind the Bidder to a contract.
- I. A bid by a corporation shall give the State of Incorporation and have the corporate seal affixed.
- J. A Bid submitted by an agent shall have a current Power of Attorney attached certifying the agent's authority to bind the Bidder.
- K. Bid Modification or Withdrawal:
 - 1. A Bid may not be modified or withdrawn or canceled by the Bidder following the time and date designated for receipt of Bids.
 - 2. Prior to the time and date designated for receipt of Bids, the Bidder may modify or withdraw the Bid by:
 - a. Written notice over the signature of the Bidder.
 - b. Emailed if confirmed in writing over the signature of the Bidder and postmarked and mailed on or before the time set for receipt of Bids.
 - 3. Modification shall be worded so as not to reveal the amount of the original Bid.
 - 4. Withdrawn Bids may be resubmitted up to the time and date designated for receipt of Bids.
 - 5. Bid Security shall be in an amount sufficient to cover the terms of the Bid as modified or resubmitted.

1.9 BID SECURITY

- A. Each Bid shall be accompanied by a Bid Security (a Bid Bond or Certified Check) pledging that the bidder will enter into a Contract with the Owner on the terms stated in the Bid Documents, and provide Performance Bonds covering faithful completion of the Contract and payment of all obligations arising there under.
 - 1. Bid Bonds or Cashiers or Certified Checks in the amount of five percent (5%) of the Bid amount.
 - a. Bid Bonds shall be on the form described in Section 00 21 13 – Instructions to Bidders the bid documents.
 - 2. Cashiers or Certified checks shall be drawn on a bank or a bank chartered under the laws of the State of Illinois, the United States and shall be payable to the Owner.
- B. The Owner reserves the right to retain the Bid Security of Bidders to whom an award is being considered until either:
 - 1. The contract has been executed and bonds have been furnished, or
 - 2. The specified time for holding bids has elapsed so that bids may be withdrawn, or
 - 3. All Bids have been rejected.

1.10 BID ATTACHMENTS

- A. Contractor's Qualification Statement
 - 1. Submitted on form provided in Section 00 45 13.

- B. List of Subcontractors and Suppliers:
 - 1. The Bidder shall, within 24 hours of submitting the bid, supply in writing the following:
 - a. Designation of Work to be performed by Bidder's own forces, and
 - b. Names of persons or entities subcontracted for the principal portions of the Work.
 - c. List trade or component of Work, name, address, telephone and contact person of subcontractor or supplier, and value of Work to be performed or supplied by that subcontractor or supplier.

1.11 BIDDERS REPRESENTATIONS - GENERAL

- A. In submitting a Bid, the Bidder represents that:
 - 1. The Bidder has read and understands all the Bid Documents to the extent that the Documents relate to the Work for which the Bid is submitted and that the Bid is made in accordance therewith.
 - 2. The Bidder has become familiar with the site and local conditions under which the Work is to be performed and has correlated the Bidder's observations with the requirements of the Bid Documents.
 - 3. The Bid is based on the materials, equipment, and systems required by the Bid Documents without exception.
 - 4. The Bid will remain open for sixty (60) days after the date of Bid opening.

1.12 BIDDERS REPRESENTATIONS

- A. In submitting a Bid, the Bidder represents that:
- B. Tax Exempt Status: The Bidder acknowledges that the Owner is exempt from the State of Wisconsin Sales and Use Tax. To that end, bids shall not include sales tax. The successful bidder shall coordinate with the owner the delivery of the appropriate certifications and Tax Exemption Identification Number following award of contract.

1.13 RECEIPT AND OPENING OF BIDS

- A. Bidder assumes all responsibility for timely delivery at the location specified in Section 00 11 13 – Advertisement for Bids.
 - 1. Any modifications to the time and or place of bid receipt shall be by written addendum only.
 - 2. Bids received after the designated time shall be returned unopened.
 - 3. Oral, telephonic, telegraphic, or faxed Bids are invalid and will not receive consideration.
- B. Properly identified Bids received on time will be opened publicly and read aloud.
- C. An abstract of the Bids will be made available within a reasonable time.

1.14 CONSIDERATION OF BIDS

- A. It is the intent of the Owner to award a Contract to the lowest responsible Bidder provided:
 - 1. The Bid has been submitted in accordance with the Bid Documents
 - 2. The Bid does not exceed the funds available.
- B. The Owner shall have the right to:
 - 1. Reject any or all Bids.
 - 2. Reject any Bid not accompanied by a Bid Security or any data required by the Bid Form.
 - 3. Reject a Bid which is in any way irregular or incomplete.
 - 4. Waive informalities or irregularities in a Bid received and to accept the Bid which, in the Owner's judgment, is in the Owner's own best interests.

5. Accept Alternates in any order or combination and to determine the low Bidder on the basis of the sum of the Base Bid and accepted Alternates.

1.15 POST-BID INFORMATION

- A. Performance Bonds
 1. If awarded the Contract, the Bidder will substantially complete all Work and perform such Work so that all other trades whose Work is dependent upon the completion of this contractor's Work are able to complete their portions of the project as shown in the Project Schedule. All means required by the Contractor to maintain the schedule for their Bid Category (Contract) shall be included in their Bid.
 2. Performance Bond:
 - a. The Bidder shall, upon notice of award, furnish within ten (10) days Bonds covering the faithful performance of the Contract and payment of all obligations arising there under.
 - b. The amount of the Bond shall be one hundred percent (100%) of the total contract sum as stipulated in Section 00 73 13 – Performance and Payment Bonds.
- B. Owner's Financial Capability:
 1. The Owner shall, at the request of the Bidder to whom award is being considered, furnish reasonable evidence that financial arrangements have been made to fulfill the Owner's obligations under the Contract.
 2. The Owner shall provide such evidence no later than seven (7) days prior to the expiration of time for withdrawal of Bids.
 3. Should the Owner fail to comply with these provisions, the Bidder will not be required to enter into the Contract and the Bid Bond will be returned to the Bidder.
- C. List of Subcontractors and Suppliers:
 1. The Bidder shall, at the request of the Architect, provide evidence as to the reliability and responsibility of the parties subcontracted to furnish and perform the Work.
 2. If the Architect, after due investigation, has reasonable objection to a proposed subcontractor or supplier, the Architect shall notify the Bidder in writing. If the Architect or Owner has reasonable objection, the Bidder may, at the Bidder's option:
 - a. Withdraw the Bid, or
 - b. Submit an acceptable substitute, in which case the Bidder may submit an adjusted Base Bid or Alternate Bid price occasioned by the substitution. The Owner may:
 - 1) accept the revised price, or
 - 2) disqualify the Bidder.
 - c. In the event of a withdrawal or disqualification, the Bid Security will be returned to the Bidder.

END OF SECTION 00 21 13

1.3 BIDDERS REPRESENTATIONS

- A. Non-Collusion:
 - 1. In submitting this Bid, Bidder represents, as more fully set forth in the Agreement, that: this Bid is genuine and not made in the interest or on behalf of any undisclosed person, firm or corporation, and is not submitted in conformity with any agreement or rules of any group, association, organization, or corporation; Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; Bidder has not solicited or induced any person, firm or a corporation to refrain from bidding; and Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over Owner.
 - 2. In submitting this Bid, Bidder certifies, and in the case of a Joint Bid each party thereto certifies as to his own organization, that in connection with the bid:
 - a. The prices in the Bid have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices with any other Bidder or with any competitor.
 - b. Unless otherwise required by law, the prices which have been quoted in the Bid have not knowingly been disclosed by the Bidder, prior to opening, directly, or indirectly to any other Bidder or to any competitor.
 - c. No attempt has been made or will be made by the Bidder to induce any other person or firm to submit or not to submit a Bid for the purpose of restricting competition.
- B. In submitting this bid, the bidder makes the representations listed in the Section "Instructions to Bidders" 00 21 12 - 1.12 items B.

PART 2 - BID SCHEDULE

2.1 BASE BID – GENERAL CONSTRUCTION
--

- A. Provide the Work described in the Bid Documents inclusive of all material parts, accessories, labor, transportation, delivery and all incidental items required to provide a complete and operational installation for the sum of

–

Dollars (\$_____).

2.2 UNIT PRICING – BRICK REPOINTING AND REPLACEMENT
--

- A. UNIT PRICE 1 – ADDITIONAL BRICK REPOINTING
- B. Provide the Unit Price for every additional 100 square feet of Brick Repointing Work described in the Bid Documents inclusive of all material parts, accessories, labor, transportation, delivery and all incidental items required to provide a complete and operational installation for the sum of

_____ Dollars (\$_____).

- C. UNIT PRICE 2 – ADDITIONAL BRICK REMOVE AND REPLACE
- D. Provide the Unit Price for every additional 100 square foot of Brick Remove and Replacement Work described in the Bid Documents inclusive of all material parts, accessories, labor, transportation, delivery and all incidental items required to provide a complete and operational installation for the sum of

_____ Dollars (\$_____).

2.3 ALTERNATE BIDS:

- A. ALTERNATE BID 1 – FIREPLACE and WOOD SURROUND, BOTH SIDES
1. Base Bid: The base bid includes painted gypsum board wall face with base to match the adjacent walls in lieu of the fireplace and wood surround (both sides) as shown in Drawings.
 2. Alternate Bid: Alternate includes inclusion of fireplace and wood surrounds (both sides) as detailed in Drawings.

(ADD)_____ Dollars (\$_____).

- B. ALTERNATE BID 2 – PAINT BOTH NORTH and SOUTH STAIRWELLS
1. Base Bid: All Base bid has no work in this area.
 2. Alternate Bid: Paint all walls; railings, steel stringers, risers and steel tread lips, underside of landings and stair runs.

(ADD)_____ Dollars (\$_____).

- C. ALTERNATE BID 3 – ADDITIONAL OPENINGS in BASEMENT ROOMS B10 and B11.

1. Base Bid: Base bid has no work in this area.
2. Alternate Bid: Alternate includes creating new openings as shown,

(ADD)_____ Dollars (\$_____).

- D. ALTERNATE BID 4 – NEW CONCRETE TOPPING SLAB at ROOM B03.

1. Base Bid: Base bid has no work in this area.
2. Alternate Bid: Alternate includes removal of existing plywood sub floor, broom clean and vacuum newly exposed sub-slab, necessary preparation of existing sub-slab to receive new topping and installation of new topping slab.

(ADD)_____ Dollars (\$_____).

- E. ALTERNATE BID 5 – PROVIDE NEW ELEVATOR CAB INTERIOR FINISHES

1. Base Bid: Base bid has no work in this area.
2. Alternate Bid: Alternate includes removal of existing flooring, wall panels and ceiling. Prep floor pan as required for new flooring install, new flooring to be linoleum sheet flooring. Walls to be new Plastic Laminate panels matching PLAM listed on Material Schedule. Ceiling to be a cloud of ACT-1 as listed on the Material Schedule with cove lighting at the perimeter above.

(ADD)_____ Dollars (\$_____).

PART 3 - CERTIFICATES AND SIGNATURES

3.1 THE BIDDER ACKNOWLEDGES RECEIPT OF THE FOLLOWING ADDENDA:

- A. Addendum _____, dated _____.
- B. Addendum _____, dated _____.
- C. Addendum _____, dated _____.

3.2 THE BIDDER HAS ATTACHED THE FOLLOWING ITEMS TO THIS BID FORM:

- A. Qualification Statement, Section 004513.
- B. Bid Bond

3.3 SIGNATURES AS REQUIRED TO BIND THE BIDDER.

I, _____ (name) certify that I am employed as the
 _____ (title) of _____ (company),

a bidder for the prime contract for the work described in the bid to which this certificate is attached, and I hereby certify that I am authorized to make this certificate and that I have personal knowledge of the matters certified to herein.

 Signature



 Name

 Title

 Date



Corporate Seal (if required)

END OF SECTION 00 41 13

**SECTION 00 45 13
QUALIFICATION STATEMENT**

PART 1 - GENERAL

1.1 OWNER RECEIPT OF QUALIFICATION STATEMENTS

- A. Qualification Statements are to be appended to the Bid Form and submitted as part of the Bid.
1. Provide all attachments identified in the body of the attached form.
 2. Provide telephone numbers and addresses for all corporations, individuals or entities listed as references or sources of information in the body of the form or the required attachments.
 3. Form shall be signed and notarized. Signatory party shall be as legally designated to bind the corporation.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 BIDDER INFORMATION

By:	_____	
Name	_____	<input type="checkbox"/> Corporation
Company	_____	<input type="checkbox"/> Partnership
Address	_____	<input type="checkbox"/> Individual
City/State/Zip	_____	<input type="checkbox"/> Joint Venture
Phone	_____	<input type="checkbox"/> Other
Fax	_____	
Type of Work	General Construction	

The submitter certifies under oath that the information provided herein is true and sufficiently complete so as not to be misleading. The information provided will be used in evaluating the ability of the potential bidder to complete the proposed work and shall be held in confidence.

3.2 ORGANIZATION

A.	How many years has your organization been in business as a contractor?	
B.	How many years has your organization been doing business under its present business name?	

C.	Under what other names has your organization operated under?	
----	--	--

Name	Time frame

D.	Corporate Information: Complete this section if your organization is a corporation.
----	---

Date of Incorporation
State of Incorporation
President's Name
Vice President's name(s)
Secretary's Name
Treasurer's name

E.	Partnership Information: Complete this section if your organization is a partnership.
----	---

Date of Organization
Type of Partnership
Names of General Partners

F.	Individual Ownership Information: Complete this section if your organization is individually owned.
----	---

Date of Organization
Name of Owner:

G.	If other than the types identified above, describe your organization and name the principal individuals.
Description	
Name of Principals:	

H.	Licensing: List the jurisdictions and trade categories in which your organization is licensed or registered to do business	
Trade Area	Jurisdiction	License or Registration No.

I.	Licensing: List the jurisdictions in which your organization's partnership or trade name is filed
Organization or Trade Name	Jurisdiction

3.3 HISTORY

A.	Experience: List the categories of work your organization normally performs with it's own forces.
<hr/> <hr/> <hr/>	
B.	On a separate sheet, list construction projects your organization has in progress. Provide the following information for each project:
Name of Project	
Name of Owner (Include contact name and phone number)	
Name of Architect (Include contact name and phone number)	
Contract Amount	
Percent Complete	
Scheduled Completion Date	
State the total value of Work in progress. \$	
<hr/> <hr/>	
C.	On a separate sheet, list the construction projects that are of similar size, complexity that your firm has completed in the past five years. Provide the following information for each project:
Name of Project	
Name of Owner (Include contact name and phone number)	
Name of Architect (Include contact name and phone number)	
Contract Amount	
Completion Date	
Percentage of total cost of the work completed with your own forces.	
<hr/> <hr/>	
D.	Claims and Suites: If the answer to any of these is yes, attach details.
Has your organization ever failed to complete any work awarded to it?	
<hr/>	
Are there any judgments, claims, arbitration proceedings or suits pending with regards to contracts within the last five years?	
<hr/>	
Has your organization filed any lawsuits or requested arbitration with regard to contracts within the last five years?	
<hr/>	
Has any officer or principal of your organization ever been an officer or principal of another organization when it failed to complete a contract?	
<hr/>	

3.4 REFERENCES

A.	Trade References
----	------------------

1	Name
	Company
	Address
	City/State/Zip
	Phone
	Fax
2	Name
	Company
	Address
	City/State/Zip
	Phone
	Fax
3	Name
	Company
	Address
	City/State/Zip
	Phone
	Fax

B.	Bank References
----	-----------------

1	Name
	Company
	Address
	City/State/Zip
	Phone
	Fax

2	Name
	Company
	Address
	City/State/Zip
	Phone
	Fax

C.	Surety
----	--------

Information for Bonding Company

1	Name
	Company
	Address
	City/State/Zip
	Phone
	Fax

Information for Agent

1	Name
	Company
	Address
	City/State/Zip
	Phone
	Fax

3.5 FINANCIAL INFORMATION

A.	Financial Statement: Attach a financial statement, preferably audited, including your organization's latest balance sheet and income statement showing Current Assets, Net Fixed Assets, Other Assets, Current Liabilities, Other Liabilities. The financial statement attached should be for the identical organization named on page 1.
----	---

B.	Name of firm providing attached financial statement and date thereof.
----	---

1	Name
	Company
	Address

City/State/Zip

Phone

Fax

3.6 KEY PERSON INFORMATION

A.	Provide relevant date for the Project Manger to be assigned to this project: Attach a separate sheet if necessary.
----	---

1 Name:

2 Experience with current organization

Project Name	Dates Start/Finish	Responsibilities

3 Past experience with other organizations

Employer	Dates Start/Finish	Responsibilities

4 References

Name/Title	Phone	Project

B.	Provide relevant date for the Site Superintendent to be assigned to this project: Attach a separate sheet if necessary.
----	---

1 Name:

2 Experience with current organization

Project Name	Dates Start/Finish	Responsibilities

3 Past experience with other organizations

Employer	Dates Start/Finish	Responsibilities

4 References

Name/Title	Phone	Project

3.7 SIGNATURES

_____ Signature	↘		↙
_____ Name			
_____ Title			
_____ Date	↗		↖
		Corporate Seal (if required)	
WITNESS			
_____ Signature	↘		↙
_____ Notary			
_____ Date			
_____ Commission Expiration Date	↗		↖
		Notary Seal	

END OF SECTION 00 45 13

**SECTION 005213
FORM OF AGREEMENT**

STIPULATED SUM – SINGLE PRIME CONTRACT

PART 1 - GENERAL

1.1 FORM OF AGREEMENT

- A. It is the intent of the Owner to enter into a Standard Form of Agreement between Owner and Contractor AIA A105 2017.
- B. All contracts based on successful bids shall be subject to review and approval of the Owner and its legal counsel.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION – Not Used

END OF SECTION 00 52 13

**SECTION 00 72 13
GENERAL CONDITIONS OF THE CONTRACT**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Form of General Conditions
- B. Related Sections
 - 1. Section 00 73 00 – Supplementary Conditions
 - 2. Section 00 73 13 – Performance and payment Bond Requirements.
 - 3. Section 00 73 16 – Insurance Requirements.

1.2 GENERAL CONDITIONS

- A. It is the intent of the Owner to incorporate into the Agreement the General Conditions of the Contract for Construction, AIA A201 –2017.

1.3 PROPOSED MODIFICATIONS

- A. See attached edited A201.

END OF SECTION 00 72 13

SECTION 00 73 00 SUPPLEMENTARY CONDITIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes.
 - 1. Interpretation of Documents
 - 2. Contractor Payment Conditions
 - 3. Retainage
 - 4. Employment
 - 5. Hours of Work- Overtime
 - 6. Progress and Completion

- B. Related Sections.
 - 1. Section 00 72 13 – General Conditions.
 - 2. Section 01 26 00 – Contract Modification Procedures: Changes in the Work
 - 3. Section 01 29 00 – Payment Procedures: Waivers of Lien.

1.2 INTERPRETATION OF DOCUMENTS

- A. In the event that conflicts exist within the contract documents, it shall be assumed that the contract includes the item(s) of higher value and/or quantity or the most restrictive method on installation. The Architect shall provide final interpretation and directions.

1.3 CONTRACTOR PAYMENT CONDITIONS

- A. Contractor is responsible for receipt, storage and protection of all materials and equipment for the Work, and for the safety and integrity of the Project site during the Work. Unless otherwise provided, all materials and equipment shall be new and free from defects. Workmanship shall be of the best quality and free from defects.
 - 1. If the Contractor should default in any material provision of this Contract, the Owner, in addition to all other rights provided by law, may require the Contractor, without cost to the Owner, to remove any work not in accordance with this Contract and perform the Work in compliance therewith.
 - 2. Should the Contractor fail to correct the Work following written notice from Owner, the Owner shall have the right to complete the corrections itself (or by work of a designated party) and to hold Contractor responsible for all costs thereof.
 - 3. Acceptance of the Project and payment of any retainage on the Project shall not release Contractor from the requirements of this clause on quality

- B. Whenever any employee, agent or other representative of any contractor, or any employee, agent or other representative of a subcontractor, material man, supplier, or delivery man whose activities on or about the site arise out of the work of a contractor, shall cause or be a substantial factor in causing any damage (including but not limited to cracking, gouging, breaking, scratching, marring, puncturing, loosening, weakening, shifting, obstructing, soiling, staining, splattering, wetting, burning, overheating, freezing, exposing, disconnecting, misconnecting, failure to guard or protect, and depriving support) to the work, materials or property of a third party (including, but not limited to the Owner, other Contractors, subcontractors, material men, suppliers, delivery men, frequenters, security holders, adjacent tenants, bodies politic, utilities, or members of the public) such contractor shall promptly proceed to remedy and correct such damage and pay all costs, expenses, and damages involved.

1. To the extent such Contractor shall fail to do so, he shall be accountable, under his Contract with the Owner, for all therefrom, whether liquidated or not, and whether certain or contingent, including but not limited to costs of renovation, repair, replacement, relocation, vicarious liabilities, losses by delays, charges for architectural or other services, and extra costs, charges, work or material of every description.
 2. Upon certification by the Architect of the identity of the responsible Contractor and of the extent of such damage so caused, Owner shall be entitled, for its security, to withhold or deduct from payments otherwise due such contractor, any sum reasonably estimated to be required or secure Owner's right to such account, until Owner shall otherwise be fully indemnified and made whole. Such liability to account shall be deemed contractual, and shall arise strictly, regardless of whether or not circumstances of conventional tort are present or proven, and shall bind the sureties and indemnities of such Contractor; but the Owner shall not be deemed to have waived, released, settled, or otherwise impaired its right to full account by reason of any payment, withholding, deduction, failure to withhold or deduct, or other form of claim or failure to claim; and in no event shall exercise or non-exercise of the Owner's right be deemed or implied to impose on the Owner any liability toward any other person; or to affect, except as expressly provided, the rights or liabilities of any of the parties arising independently of this provision.
- C. Whenever the Contractor or Contractors whose activities cause any such damage cannot, in the opinion of the Architect, be specifically ascertained, or whenever a Contractors' proportionate responsibility to account therefor according to the foregoing provisions cannot in the opinion of the Architect be finally determined, the Contractor(s) to whose general division(s) the damage pertains shall proceed promptly to remedy and correct such damage as extra work, and the reasonable charges for so doing, together with the amounts of any further damages which may so arise, shall be certified by the Architect to the Owner, with authorization to charge the aggregate sum to the respective accounts of all contractors who, directly or through subcontractors, material men, suppliers or delivery men, were engaged in any activity at the site of the damage when it arose, in proportion to the gross amounts of their respective contracts. Such allocated accountability shall continue, as security to the Owner, until a different accountability is ascertained, in the opinion of the Architect or until the Owner is otherwise fully indemnified and made whole.

1.4 RETAINAGE

- A. As provided in AIA A201-2017 Edition, Retainage shall be made on each application for payment in the amount of 5% of the work completed to date.
- B. At Substantial Completion, upon approval by Owner and Architect's determination, payments shall be authorized for the total retainage in the Contract less an amount equal to twice the established cost to complete or correct items on the tentative list of uncompleted items may be retained until final completion.

1.5 EMPLOYMENT

- A. The Contractor and all trades shall conduct all their operations on this Project in such a manner that no labor jurisdictional disputes arise.
- B. Contractor shall comply with all applicable laws and regulations relating to employment, including, but not limited to, the Fair Labor Standards Act and the Occupational Safety and Health Act of 1970. Contractor shall hold the Owner harmless from and reimburse it for any and all costs, damages and expenses (including attorney's fees) suffered by it directly or indirectly through the failure of Contractor to comply with any such laws, regulations or orders.
- C. Labor: Contractors and subcontractors employed upon work shall be required to conform to Labor Laws of the State in which the Project is located and various acts amendatory and supplementary thereto and to other law, ordinance and all requirements applicable thereto.

1. Foremen, mechanics and employees of contractor whose work is unsatisfactory to Owner, or Architect or are considered to be careless, incompetent, unskilled or otherwise objectionable shall be dismissed from work upon notice from the Owner.
2. It shall be duty of every contractor engaged in this work to enforce among all workmen directly or indirectly employed by him, all rules which Owner may lay down for conduct of workmen on premises.

1.6 HOURS OF WORK - OVERTIME

- A. If, for any reason, the required work cannot be performed during normal working hours on normal working days as defined by local ordinance, special arrangements can be made with the Owner to perform the work on evenings and on Saturday or Sunday.
- B. No extra compensation will be allowed because of premium time provided for Contractor's convenience or to comply with schedule.
- C. If and when overtime work is required and authorized by Owner, the Owner will pay by Change Order, at established rates, the increase in hourly pay due to overtime hours worked, exclusive of Contractor's overhead and profit, upon approval of payroll records.

1.7 PROGRESS AND COMPLETION

- A. Contractor shall begin work upon written notice to proceed and shall diligently execute work to its final completion by the date agreed upon with Owner.
- B. No extension of time beyond completion date stated will be allowed without the Owner's written consent. In order to qualify for such an extension, the Contractor must notify the Architect in writing five working days immediately following the occurrence of such circumstances to justify an extension, or the contractor will have been deemed to have waived his right to an extension of time.
- C. Time of completion shall be strictly adhered to. In case of failure on part of contractor to execute his work satisfactorily, Owner reserves right to employ other means to complete work as described in Contract Documents.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION – Not Used

END OF SECTION 00 73 00

SECTION 00 73 13
PERFORMANCE AND PAYMENT BOND REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Performance and Payment Bond
- B. Related Section
 - 1. Section 00 52 13 – Form of Agreement: Other provisions regarding Bonds
 - 2. Section 00 72 13 – General Conditions

1.2 PERFORMANCE BOND

- A. The Apparent Low Bidder shall, upon Notice of Award, provide a Performance Bond/Labor &Material Payment Bond for 100% of the amount of the total Bid.
- B. Bonds shall comply with the following:
 - 1. The Bonding Company shall be licensed to do business in the State in which the Project is located.
 - 2. The Bonding Company shall have an A. M. Best rating of IX or better.
- C. The form of the Bond shall be AIA A-312 or equivalent and shall include sections applicable to Performance and Payment.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION 00 73 13

SECTION 00 73 16 INSURANCE REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. General Requirements
 - 2. Workers Compensation Insurance
 - 3. Comprehensive General Liability Insurance
 - 4. Comprehensive Automobile Insurance
 - 5. Subcontractors Insurance Requirements.
- B. Related Sections
 - 1. Section 00 52 13 – Agreement: Provisions regarding Insurance.

1.2 GENERAL REQUIREMENTS

- A. Certificates: All certificates of insurance required to be obtained by Contractor shall conform to the following:
 - 1. All policies shall be issued by companies authorized to do business in the State where the project is located.
 - 2. The Contractor shall provide insurance in compliance with an A. M. Best insurance rating of A, 8 or better. Such insurance shall include the scheduled coverages in the scheduled amounts.
 - 3. The coverage under the policies named shall not be cancelled, modified, reduced or allowed to expire without at least 30 days prior written notice given to the Owner.
 - 4. All certificates evidencing coverage extended beyond the date of final payment shall be provided at the time of the Final Pay Application.
 - 5. All certificates of insurance shall name the following as additional insured:
Use formal corporate names for all parties.
 - a. Vaughn Public Library
 - b. City of Ashland
 - c. Engberg Anderson, Inc.
 - 6. All insurance required of the Contractor shall state that it is Primary Insurance as to all additional insureds with respect to claims arising out of operations by or on their behalf. If additional insureds have other applicable insurance coverages, those coverages shall be regarded as on an excess or contingent basis.
 - 7. The Contractor shall require that every subcontractor of any tier obtain insurance of the same character as that required of the Contractor, naming the same additional insureds and subject to the same restrictions and obligations as set forth for the Contractor's insurance in the Contract Documents.
- B. Submittals
 - 1. Certificates of Insurance in the amounts specified below must be submitted to the Architect within 10 days of award.
 - 2. No Work shall be allowed to start until such requirements have been satisfied by all contractors and subcontractors.
 - 3. Upon the request of the Owner, the Bidder shall provide a copy to the Owner of all insurance forms relevant to the Owner's interest. The forms must be satisfactory to the Owner.
 - 4. Under no circumstances shall the Owner be deemed to have waived any of the insurance requirements of these Contract by act or omission, including, but not limited to:

- a. Allowing the Contractor or any subcontractor of any tier to start before receipt of certificates of insurance.
 - b. Failure to examine or to demand correction of any deficiency, of any certificate of insurance received.
5. The Contractor shall notify the Owner, in writing, of any possible or potential claim for personal injury or property damage arising out of the work of this Contract promptly whenever the occurrence giving rise to such a potential claim becomes known to the Contractor.
- C. The Contractor agrees that the obligation to provide insurance is solely the Contractor's responsibility and cannot be waived by any act or omission of the Owner.
1. Compliance with this section does not relieve the Contractor of liabilities and responsibilities as defined in the Bid Documents.
 2. The purchase of insurance by the Contractor under this Contract shall not be deemed to limit the liability of the Contractor in any way, for damages suffered by the Owner in excess of policy limits or not covered by the policies purchased.
- D. Wherein the terms of this section are in conflict with the terms of the contract conditions, the terms of this section shall prevail.

1.3 WORKERS COMPENSATION INSURANCE:

- A. Statutory coverage as required by the State in which the project is located.
1. Must carry coverage for Statutory Workers Compensation and an Employers Liability with limits of:
 - a. \$500,000 Each Accident
 - b. \$1,000,000 Disease Policy Limit
 - c. \$500,000 Disease – Each Employee
 2. Employers Liability limits must be sufficient to meet umbrella liability.
- B. All Sub-contractors and material suppliers shall furnish to the Contractor and Owner evidence of similar insurance for all of their employees unless such protection is afforded by the Contractor.

1.4 COMPREHENSIVE GENERAL LIABILITY INSURANCE:

- A. Bidder shall provide Contractor's Protective Liability Policy (CPLP) coverage to include
1. Premises, including staging, storage and layout areas, products & Operations are to be covered by the CPLP policy
 2. The CPLP policy shall be primary and non-contributory.
 3. Policy shall be maintained in force for 2 years beyond the date of Final Completion.
 4. Policy shall include:
 - a. Broad Form Property Damage Endorsement.
 - b. Blanket Contractual Liability.
 - c. Personal injury Liability.
- B. Coverage shall include explosion (x), collapse (c), and underground property damage (u) hazard exposures.
- C. Coverage shall be subject to a combined limit of not less than:
1. \$5,000,000.00 per occurrence
 2. \$5,000,000.00 aggregate

1.5 COMPREHENSIVE AUTOMOBILE LIABILITY INSURANCE:

- A. Coverage to include operation of owned, hired, and non-owned motor vehicles.
- B. Coverage shall be subject to a combined single limit of not less than \$1,000,000.00

1.6 SUB-CONTRACTORS INSURANCE:

- A. The Contractor shall require and obtain evidence that each subcontractor has their own insurance coverages in conformance with the following schedule.
- B. General Liability:
 - 1. \$1,000,000.00 per occurrence
 - 2. \$2,000,000.00 aggregate
 - 3. Additional Insureds are to include the Contractor, the Owner, the City and the Architect.
- C. Workers Compensation
 - 1. Statutory coverage as required by the State in which the project is located.
- D. Auto Liability
 - 1. \$1,000,000 combined single limit.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION 00 73 16

SECTION 01 10 00 SUMMARY

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 SECTION INCLUDES

- A. This Section includes the following:
 1. Application.
 2. Project Information
 3. Work covered by Contract Documents.
 4. Work under separate contracts.
 5. Future work.
 6. Owner-furnished products.
 7. Access to site.
 8. Use of premises.
 9. Coordination with occupants.
 10. Work restrictions.
 11. Specification formats and conventions.
 12. Miscellaneous Provisions

1.3 PROJECT INFORMATION

- A. Project Identification: Vaughn Public Library – Renovation Project
- B. Owner: City of Ashland, Sarah Adams, Library Director
- C. Architect: Joselia Mendiola, Engberg Anderson, Inc.
- D. Architect's Consultants: The Architect has retained the following design professionals who have prepared designated portions of the Contract Documents. Contact information can be found on the title sheet in the drawing set.
 1. Civil – Cooper Engineering
 2. Structural – Spire Engineering
 3. MEP/FP – Salas O'Brien Engineering

1.4 CONTRACT DOCUMENTS - INTENT AND USE

- A. Intent of Documents:
 1. It is the intent of the Contract Documents to provide a complete project within the scope shown and specified.
 2. Singular notations and specifications shall be considered plural where application is reasonably inferred.
 3. Mention or indication of extent of work under any work division or specification section is done only for convenience of Contractor and shall not be construed as describing all work required under that division or section.
 4. The list of related sections in individual sections is provided for the convenience of Contractor and is not necessarily all-inclusive. Contractor may not rely upon this listing for determination of

scope of Work. Other sections of the specifications, not referenced in individual sections shall apply as required for proper performance of the Work.

5. Command type sentences may be used in the Contract Documents. These sentences refer to and are directed to Contractor.
 6. Symbols for various elements and systems are shown on the drawings. Should there be any doubt regarding the meaning or intent of the symbols used, a written interpretation shall be obtained from the Engineer.
- B. Use of Documents:
1. Contractor shall examine all Specifications and drawings for the work; including those that may pertain to work Contractor does not normally perform with its own forces.
 2. Contractor shall use all of the project Drawings and Specifications:
 - a. For a complete understanding of the project.
 - b. To determine the type of construction and systems required.
 - c. For coordination with other contractors.
 - d. To determine what other work may be involved in various parts or phases.
 - e. To anticipate and notify others when work by others will be required.
 - f. And all other relevant matters related to the project.
 3. Contractor is also bound by all requirements of the Contract Documents which are applicable to, pertain to, or affect its work, as may be shown or inferred by the entire set of project drawings and specifications.

1.5 PROJECT SCOPE

- A. Contractor shall provide all items, articles, materials, operations or methods mentioned or scheduled on the drawings or herein specified including all labor, supervision, equipment, incidentals, taxes and permits necessary to complete the Work as described within the Contract Documents. Contractor shall install all items provided by Owner as mentioned or scheduled on the drawings or herein specified.

1.6 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and generally consists of the following:
1. Interior renovation of the existing Library is extensive on Floors One, Two and Three. Work includes selective demolition; construction of convenience stairs; partitions; ceilings; doors, frames and hardware; finishes; millwork and cabinetry; appliances; new and modified building systems; new plumbing fixtures and accessories; new and modified electrical and data cabling systems.
 2. Interior renovation of the existing Library's Basement is limited to demolition for investigation and needed repairs, equipment replacement, inclusion of a new IT Room.
 3. Exterior modifications include new windows, doors and storefront; existing wood restoration; a new roof hatch and associated ladder, curb and guardrail and roof patching where new hatch is installed and where old hatch is removed.
 4. Alternates are outlined in Section 01 23 00 - Alternates.
- B. Type of Contract:
1. Project will be constructed under a single prime contract.

1.7 WORK UNDER SEPARATE CONTRACTS

- A. General: Cooperate fully with the Owner and separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.
- B. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract.
 - 1. Rough-in for Systems to be installed after Substantial Completion, noted below.
- C. Subsequent Work: Owner will perform the following additional work at site after Substantial Completion. Completion of that work will depend on successful completion of preparatory work under this Contract.
 - 1. Audio Visual Equipment
 - 2. Furnishings and Loose Equipment

1.8 ACCESS TO SITE

- A. General: Contractor shall have full use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

1.9 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Work hours are flexible and can be coordinated with the Library. Contractor will be provided with access as required to best support the progress of the project.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
 - 1. Notify Architect and Owner not less than 2 working days in advance of proposed utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 - 1. Notify Architect and Owner not less than 2 working days in advance of proposed disruptive operations.
- E. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances, operable windows, or outdoor air intakes.

1.10 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Drawing Coordination: Requirements for materials and products identified on the Drawings are described in detail in the Specifications. One or more of the following are used on the Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 23 00 ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Administrative and procedural requirements governing Alternates.
- B. Schedule of Alternates

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
 - 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate the Alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent Work as necessary to completely and fully integrate that Work into the Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not mentioned as part of the Alternate.
- B. Notification: Immediately following the award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate whether alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of this Contract.
- D. Schedule: A "Schedule of Alternates" is included at the end of this Section. Specification Sections referenced in the Schedule contain requirements for materials necessary to achieve the Work described under each alternate.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. ALTERNATE BID 1 – FIREPLACE and WOOD SURROUND, BOTH SIDES
1. Base Bid: The base bid includes painted gypsum board wall face with base to match the adjacent walls in lieu of the fireplace and wood surround (both sides) as shown in Drawings.
 2. Alternate Bid: Alternate includes inclusion of fireplace and wood surrounds (both sides) as detailed in Drawings.
 3. Reference Drawings: A101, A302, A800, A903.
- B. ALTERNATE BID 2 – PAINT BOTH NORTH and SOUTH STAIRWELLS
1. Base Bid: All Base bid has no work in this area.
 2. Alternate Bid: Paint all walls; railings, steel stringers, risers and steel tread lips, underside of landings and stair runs.
 3. Reference Drawings: A100, A101, A700
- C. ALTERNATE BID 3 – ADDITIONAL OPENINGS in BASEMENT ROOMS B10 and B11
1. Base Bid: Base bid has no work in this area.
 2. Alternate Bid: Alternate includes creating new openings as shown
 3. Reference Drawings: D100, A100, A601, A710
- D. ALTERNATE BID 4 – NEW PLYWOOD FLOORING at ROOM B03.
1. Base Bid: Base bid has no work in this area.
 2. Alternate Bid: Alternate includes removal of existing plywood floor, broom clean and vacuum newly exposed sub-floor, necessary preparation of existing sub-floor to receive new marine grade plywood floor surface.
 3. Reference Drawings: D100, A100.
- E. ALTERNATE BID 5 – PROVIDE NEW ELEVATOR CAB INTERIOR FINISHES
1. Base Bid: Base bid has no work in this area.
 2. Alternate Bid: Alternate includes removal of existing flooring, wall panels and ceiling. Prep floor pan as required for new flooring install, new flooring to be linoleum sheet flooring. Walls to be new Plastic Laminate panels matching PLAM listed on Material Schedule. Ceiling to be a cloud of ACT-1 as listed on the Material Schedule with cove lighting at the perimeter above.
- F. ALTERNATE BID 6 – LOWER SANITARY SEWER LATERAL
1. Base Bid: Base bid has no work in this area.
 2. Alternate Bid: Alternate includes reworking the existing 6" PVC sanitary sewer lateral from 5 feet inside the building (Room B07x) east to the city main within Vaughn Avenue. The existing sewer is at approximately elevation 645' and the existing main line is at approximately 639'. The intent is to lower the connection as far as possible while maintaining positive drainage.

END OF SECTION 01 23 00

SECTION 01 26 00 CONTRACT MODIFICATION PROCEDURES

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 SECTION INCLUDES

- A. Administrative and procedural requirements for handling and processing contract modifications.
 - a. Minor Changes in the Work
 - b. Proposal Requests
 - c. Change Order Procedures
 - d. Construction Change Directives

1.3 MINOR CHANGES IN THE WORK

- A. The Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or Contract Time.

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: The Architect will issue a detailed description of proposed changes in the Work that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Proposal requests issued by the Architect are for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.
 - 2. Within 20 days of receipt of a proposal request, submit an estimate of cost necessary to execute the change to the Architect for the Owner's review.
 - a. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.
 - d. Quotation Form: Use CSI Form 13.6D, "Proposal Worksheet Summary," and Form 13.6C, "Proposal Worksheet Detail."
- B. Contractor-Initiated Proposals: When latent or unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the Architect.
 - 1. Include a statement outlining the reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and Contract Time.
 - 2. Include a list of quantities of products required and unit costs, with the total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.
5. Comply with requirements in Section "Product Substitutions" if the proposed change requires substitution of one product or system for a product or system specified.
6. Change Order Proposal Request Form: Use AIA Document G709 for Change Order Proposal Requests.

1.5 ADMINISTRATIVE CHANGE ORDERS

- A. Unit-Price Adjustment: See Section 01 22 00 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.6 CHANGE ORDER PROCEDURES

- A. Upon the Owner's approval of a Proposal Request, the Architect will issue a Change Order for signatures of the Owner and the Contractor.

B. Changes in the Work:

1. For changes in the Work, the cost shall be determined as provided under this subparagraph. The Contractor shall submit an itemized list of quantities with the applicable unit costs and extended price for each, in such form and detail and shall include and indicate the items enumerated below. Items (a) and (b) constitute the cost of labor, and items (a), (b), (c) and (d) constitute the basic costs referred to under this Article.
 - a. Labor costs, itemized by each trade involved, showing the hourly rates for each, and the hours required for the change. Labor rates shall be the same for extra and credit computations and shall be the actual rate paid the workman in accordance with established management labor agreements.
 - b. Burden on labor, which shall be only the actual costs of mandatory fringe benefits required by established agreements, taxes on labor, worker's or workmen's compensation, insurance on labor as affected by payroll, unemployment taxes and insurance, including FICA and FUTA. No other costs will be allowed as burden on labor.
 - c. Quantities of materials, equipment and supplies, at their actual costs, with unit costs indicated.
 - d. The cost of subcontracted work, computed in the same way as provided for under this subparagraph.
 - e. Overhead, profit and commission.
2. The maximum that will be allowed for overhead and profit, or commission, shall be as follows, expressed as a percentage of the basic cost of the change.
 - a. The maximum allowable percentages for profit, overhead or commission may be less, depending on the nature, extent or complexity of the change, where the percentage is not commensurate with the responsibility and administration involved (such as the Contractor merely processing a substantial Change Order to a Subcontractor) but in no event shall they exceed the following:

	Overhead & Profit	Commission
1.To the Contractor and/or its Subcontractor for work performed with their own forces:	10%	0%
2.To the Contractor and/or its Subcontractor for work performed by other than their own forces:	0%	5%

3. Not more than above specified percentages for overhead, profit and commission will be allowed to be added to the basic cost regardless of the number of tiers of Contractors, Subcontractors, or Sub-subcontractors.
4. The burden on labor may be indicated as a dollar/cents addition to the hourly rate or may be expressed as a percentage of the extended hourly rate costs. If required by the Owner or the Architect, the Contractor shall provide a detailed breakdown to justify the labor burden. The Owner shall reserve the right to reject any labor burden which is inconsistent with other similar contractors or where the cost of fringe benefits are in excess of established labor agreements.
5. Material, equipment and supply costs shall be quoted at the actual cost to the Contractor, or Subcontractor. Upon request, the Contractor (or Subcontractor) shall submit evidence to substantiate the costs. Said costs shall be quoted at trade discount prices, with quantity discounts also applied where the quantities warrant. In any proposal with material, equipment and supply credit, the credit shall be based on the actual Contract cost of the material (including trade and quantity discounts) less any charges actually incurred for handling or returning a material which has been delivered.
6. The percentages allowed for overhead, profit or commission shall be deemed to include, and no further addition allowed the Contractor, Subcontractor or Sub-subcontractors for: (1) field and office supervision and administration, including the field superintendent and non-working foremen; (2) general insurance, except that listed as the labor burden; (3) use or replacement of tools; (4) shop burden; (5) engineering costs; (6) performance (guaranty) and labor/material payment bonds; (7) cost of safety measures (including those imposed by OSHA); (8) permits, unless a new permit type is required; (9) or any other costs except those enumerated.
7. Cost changes shall be computed by determining the basic costs to which the overhead may be added, then the profit figure may be added and finally adding the sales tax on materials.
8. Subcontractors (or Sub-subcontractors) shall compute their costs in the same way and are subject to the same conditions of what may be included in the cost and the same maximum percentages for overhead and profit. To the Subcontractor's price, the Contractor may add up to a maximum of 5% commission.
9. For Changes involving work of the Contractor with its own forces and work by a Subcontractor (or Sub-subcontractors), the Commission shall be applied directly to the Subcontractor's price, with the overhead and profit figure applied only to the Work the Contractor performs with its own forces.
10. For Changes involving both extra and credit amounts, the overhead and profit, or commission, shall be applied only to net difference where the extra exceeds the credit.
11. For Changes resulting in a credit in the basic costs, a reasonable allowance for overhead, profit or commission may be required to be credited the Owner. In general, no credit for overhead, profit or commission will be required where the net change credit is minor or where the Change in Work indicates it is reasonable that no credit be allowed to the Owner due to the effort, cost or responsibility of the Contractor. In the event of substantial subcontract credits, or for Work the Contractor does not provide or perform, a reasonable overhead, profit or commission credit shall be allowed to the Owner.

1.7 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: When the Owner and the Contractor disagree on the terms of a Proposal Request, the Architect may issue a Construction Change Directive on AIA Form G714. The Construction Change Directive instructs the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. The Construction Change Directive contains a complete description of the change in the Work. It also designates the method to be followed to determine change in the Contract Sum or Contract Time.

- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 1. After completion of the change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00 PAYMENT PROCEDURES

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 SECTION INCLUDES

- A. This Section Includes:
 - 1. Administrative and procedural requirements governing the Contractor's Applications for Payment.
 - 2. Coordination of the Schedule of Values and Applications for Payment with the Contractor's Construction Schedule, Submittal Schedule, and List of Subcontracts.

1.3 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule.
 - 1. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:
 - a. Application for Payment forms, including Continuation Sheets.
 - b. Submittal schedule.
 - c. Contractor's construction schedule.
 - d. Schedule of allowances.
 - e. Schedule of alternates.
 - f. List of subcontractors.
 - g. List of principal suppliers and fabricators.
 - h. List of products.
 - 2. Submit the Schedule of Values to the Architect at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.
 - 3. Sub-schedules: Where Work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.
- B. Format and Content: Use the Project Manual table of contents as a guide to establish the format for the Schedule of Values. Provide at least one line item for each Specification Section.
 - 1. Identification: include the following Project identification on the Schedule of Values:
 - a. Project name and location.
 - b. Name of the Architect.
 - c. Project number.

- d. Contractor's name and address.
- e. Date of submittal.
2. Arrange schedule of values consistent with format of AIA Document G703.
3. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value as a percentage of Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
4. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
5. Round amounts to nearest whole dollar; the total shall equal the Contract Sum.
6. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.
7. Provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
8. Purchase Contracts: Provide a separate line item in the schedule of values for each purchase contract. Show line-item value of purchase contract. Indicate owner payments or deposits, if any, and balance to be paid by Contractor.
9. Each item in the Schedule of Values and Applications for Payment shall be complete. Include the total cost and proportionate share of general overhead and profit margin for each item.
10. Schedule Updating: Update and resubmit the Schedule of Values prior to the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by the Architect and paid for by the Owner.
 1. Initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

- C. Application for Payment Forms: Use AIA Document G702 and Continuation Sheets G703 as the form for Applications for Payment.
- D. Application Preparation: Complete every entry on the form. Notarize and execute by a person authorized to sign legal documents on behalf of the Contractor. The Architect will return incomplete applications without action.
 - 1. Entries shall match data on the Schedule of Values and the Contractor's Construction Schedule. Use updated schedules if revisions were made.
 - 2. Include amounts of Change Orders and Construction Change Directives issued prior to the last day of the construction period covered by the application.
- E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
 - 1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
 - 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 - 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- F. Transmittal: Submit signed and notarized of each Application for Payment to the Architect electronically. Application shall be complete, including waivers of lien and similar attachments, when required.
 - 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information related to the application, in a manner acceptable to the Architect.
- G. Waivers of Mechanics Lien: With each Application for Payment, submit waivers of mechanics lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
 - 1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 - 2. When an application shows completion of an item, submit final or full waivers.
 - 3. The Owner reserves the right to designate which entities involved in the Work must submit waivers.
 - 4. Waiver Delays: Submit each Application for Payment with the Contractor's waiver of mechanics lien for the period of construction covered by the application. Subcontractor's waivers may be submitted with the following Application for Payment.

5. Submit final Applications for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 6. Waiver Forms: Submit waivers of lien on forms, and executed in a manner, acceptable to the Owner.
- H. Initial Application for Payment: Administrative actions and submittals, that must precede or coincide with submittal of the first Application for Payment, include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Schedule of unit prices.
 5. Submittal schedule (preliminary if not final).
 6. List of Contractor's staff assignments.
 7. List of Contractor's principal consultants.
 8. Copies of building permits.
 9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 10. Initial progress report.
 11. Report of preconstruction conference.
 12. Certificates of insurance and insurance policies.
 13. Performance and payment bonds.
 14. Data needed to acquire Owner's insurance.
- I. Intermediate Applications for Payment: Administrative actions and submittals, that must precede or coincide with submittal of each Application for Payment, include the following:
1. Revisions to items identified in Initial Application for Payment:
 - a. List of subcontractors.
 - b. Schedule of values.
 - c. Updated Contractor's construction schedule.
 - d. Schedule of unit prices.
 - e. Updated Submittal schedule.
 - f. Copies of authorizations, inspection reports and licenses from governing authorities for continued performance of the Work.
 - g. Progress Meeting Report
 2. Review and Completion of Administrative Requirements of the Work including:
 - a. Resolution of Proposal Requests and Change Orders issued prior to 14 days preceding the current Application.
 - b. Record documents, including log book, product data, test reports and record drawings are current with the progress of the Work.
 - c. For purposes of accounting, the value of these functions shall be established at 5% of the payment Application in review.

- J. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment.
1. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
 2. Administrative actions and submittals that shall precede or coincide with this application include:
 - a. Occupancy permits and similar approvals.
 - b. Warranties (guarantees) and maintenance agreements.
 - c. Test/adjust/balance records.
 - d. Maintenance instructions.
 - e. Meter readings.
 - f. Startup performance reports.
 - g. Changeover information related to Owner's occupancy, use, operation, and maintenance.
 - h. Final cleaning.
 - i. Application for reduction of retainage and consent of surety.
 - j. Advice on shifting insurance coverages.
 - k. Final progress photographs.
 - l. List of incomplete Work, recognized as exceptions to Architect's Certificate of Substantial Completion.
- K. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include the following:
1. Completion of Project closeout requirements.
 2. Completion of items specified for completion after Substantial Completion.
 3. Ensure that unsettled claims will be settled.
 4. Ensure that incomplete Work is not accepted and will be completed without undue delay.
 5. Transmittal of required Project construction records to the Owner.
 6. Certified property survey, if applicable.
 7. Proof that taxes, fees, and similar obligations were paid.
 8. Updated final statement, accounting for final changes to the Contract Sum.
 9. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
 10. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
 11. AIA Document G707, "Consent of Surety to Final Payment."
 12. Evidence that claims have been settled.
 13. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 14. Removal of temporary facilities and services.
 15. Removal of surplus materials, rubbish, and similar elements.
 16. Change of door locks to Owner's access.
 17. Before Final Payment will be released the Contractor shall file, in duplicate, with the Owner, an itemized statement showing the amount of Sales Tax or Use Tax, and to whom paid on all materials which have become a part of the finished Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00 PROJECT MANAGEMENT AND COORDINATION

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. This Section specifies administrative and procedural requirements for project meetings, including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Preconstruction conferences.
 - 3. Preinstallation conferences.
 - 4. Progress meetings.

1.3 DEFINITIONS

- A. RFI: Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule.
 2. Preparation of the Schedule of Values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.
- E. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.

1.6 COORDINATION DRAWINGS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
 - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - b. Indicate required installation sequences.

- c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
2. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

1.7 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
 1. Post copies of list in Project meeting room, in temporary field office. Keep list current at all times.

1.8 REQUESTS FOR INFORMATION (RFIS)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Architect.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

- C. RFI Forms: AIA Document G716 or Software-generated form with substantially the same content as indicated above, acceptable to Architect.
 - 1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
 - 1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 - 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
 - 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log at each progress meeting. Include the following:
 - 1. Project name.
 - 2. Name and address of Contractor.
 - 3. Name and address of Architect.
 - 4. RFI number including RFIs that were returned without action or withdrawn.
 - 5. RFI description.
 - 6. Date the RFI was submitted.
 - 7. Date Architect's response was received.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Construction Manager within seven days if Contractor disagrees with response.
 - 1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 - 2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.9 PRECONSTRUCTION CONFERENCE

- A. Schedule and conduct a preconstruction conference before starting construction, at a time convenient to the Owner and the Architect, but no later than 15 days after execution of the Agreement. Hold the

conference at the Project Site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

- B. Attendees: Authorized representatives of the Owner, Construction Manager, Architect, and their consultants; the Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.
- C. Agenda: Discuss items of significance that could affect progress, including the following:
 - 1. Tentative construction schedule.
 - 2. Phasing.
 - 3. Critical work sequencing and long-lead items.
 - 4. Designation of key personnel and their duties.
 - 5. Lines of communications.
 - 6. Procedures for processing field decisions and Change Orders.
 - 7. Procedures for RFIs.
 - 8. Procedures for testing and inspecting.
 - 9. Procedures for processing Applications for Payment.
 - 10. Distribution of the Contract Documents.
 - 11. Submittal procedures.
 - 12. Preparation of Record Documents.
 - 13. Use of the premises and existing building.
 - 14. Work restrictions.
 - 15. Working hours.
 - 16. Owner's occupancy requirements.
 - 17. Responsibility for temporary facilities and controls.
 - 18. Construction waste management and recycling.
 - 19. Parking availability.
 - 20. Office, work, and storage areas.
 - 21. Equipment deliveries and priorities.
 - 22. First aid.
 - 23. Security.
 - 24. Progress cleaning.
- D. Reporting: No later than 3 days after the meeting, distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.

1.10 PROGRESS MEETINGS

- A. Conduct progress meetings at the Project Site at regular intervals, not less than twice a month. Notify the Owner and the Architect of scheduled meeting dates. Coordinate dates of meetings with preparation of the Pay Application.
- B. Attendees: In addition to representatives of the Owner, Construction Manager and the Architect, each subcontractor, supplier, or other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.

- C. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the status of the Project.
1. Contractor's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time or ahead or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to insure that current and subsequent activities will be completed within the Contract Time.
 - a. Review schedule for next period.
 2. Review the present and future needs of each entity present, including the following:
 - a. Interface requirements.
 - b. Sequence of operations.
 - c. Status of submittals.
 - d. Deliveries.
 - e. Access.
 - f. Site utilization.
 - g. Temporary facilities and services.
 - h. Construction waste management.
 - i. Progress cleaning.
 - j. Quality and work standards.
 - k. Status of correction of deficient items.
 - l. Field observations.
 - m. Status of RFIs.
 - n. Status of proposal requests.
 - o. Pending changes.
 - p. Status of Change Orders.
 - q. Pending claims and disputes.
 - r. Documentation of information for payment requests.
- D. Reporting: No later than 3 days after each meeting, distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.
1. Schedule Updating: Revise the Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue the revised schedule concurrently with the report of each meeting.

1.11 PREINSTALLATION AND COORDINATION CONFERENCES

- A. Conduct a preinstallation conference at the Project Site before each construction activity that requires coordination with other construction.
- B. Attendees: The 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 the Architect and Construction Manager of scheduled meeting dates.
- C. Agenda: Review the progress of other construction activities and preparations for the particular activity under consideration at each preinstallation conference, including requirements for the following:
1. The Contract Documents.

2. Options.
3. Related RFI's.
4. Related Change Orders.
5. Purchases.
6. Deliveries.
7. Submittals
8. Construction waste management.
9. Review of mockups.
10. Possible conflicts.
11. Compatibility problems.
12. Time schedules.
13. Weather limitations.
14. Manufacturer's written recommendations.
15. Warranty requirements.
16. Compatibility of materials.
17. Acceptability of substrates.
18. Temporary facilities and controls.
19. Space and access limitations.
20. Regulations of authorities having jurisdiction.
21. Testing and inspecting requirements.
22. Installation procedures.
23. Coordination with other work.
24. Required performance results.
25. Protection of adjacent work.
26. Protection of construction and personnel.

- D. Reporting: No later than 3 days after each meeting, distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of significant discussions and agreements and disagreements of each conference, and the approved schedule.
- E. Do not proceed with the installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of Work and reconvene the conference at the earliest feasible date.

1.12 PROJECT CLOSEOUT CONFERENCE:

- A. Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for preparing operations and maintenance data.

- e. Requirements for delivery of material samples, attic stock, and spare parts.
- f. Requirements for demonstration and training.
- g. Preparation of Contractor's punch list.
- h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
- i. Submittal procedures.
- j. Coordination of separate contracts.
- k. Owner's partial occupancy requirements.
- l. Installation of Owner's furniture, fixtures, and equipment.
- m. Responsibility for removing temporary facilities and controls.

- B. Reporting No later than 3 days after each meeting, distribute minutes of the meeting to each party present and to parties who should have been present.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 REVIEW OF ONGOING COORDINATION ACTIVITIES

- A. Review and Completion of Administrative Requirements of the Work including the work of this Section as well as the items scheduled below are required for approval of progress payments.
- 1. Resolution of Proposal Requests and Change Orders issued prior to 14 days preceding the current Application.
 - 2. Record documents, including log book, product data, test reports and record drawings are current with the progress of the Work.
 - 3. For purposes of accounting, the value of these functions shall be established at 5% of the payment Application in review.

END OF SECTION 01 31 00

SECTION 01 32 00 CONSTRUCTION PROGRESS DOCUMENTATION

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. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 1. Preliminary Construction Schedule.
 2. Contractor's Construction Schedule.
 3. Submittals Schedule.
 4. Daily Construction Reports.
 5. Material Location Reports.
 6. Field Condition Reports.
 7. Special Reports.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
 2. Predecessor Activity: An activity that precedes another activity in the network.
 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.
- C. CPM: Critical Path Method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Major Area: A story of construction, a separate building, or a similar significant construction element.

- H. Milestone: A key or critical point in time for reference or measurement.
- I. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.
- J. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. Working electronic copy of schedule file, where indicated.
 - 2. PDF electronic file.
- B. Submittals Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and Construction Manager and additional time for handling and reviewing submittals required by those corrections.
 - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 - 2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
 - 4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal category (action or informational).
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.
- C. Preliminary Construction Schedule:
 - 1. Approval of cost-loaded preliminary construction schedule will not constitute approval of Schedule of Values for cost-loaded activities.
- D. Contractor's Construction Schedule:
 - 1. Submit an electronic copy of schedule, labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.
- E. CPM Reports: Concurrent with CPM schedule. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
- F. Construction Schedule Updating Reports: Submit with Applications for Payment.
- G. Daily Construction Reports: Submit with Applications for Payment.
- H. Material Location Reports: Submit with Applications for Payment.

- I. Field Condition Reports: Submit at time of discovery of differing conditions.
- J. Special Reports: Submit at time of unusual event.

1.5 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from parties involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
 - 1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
 - 2. Initial Submittal: Submit concurrently with preliminary schedule. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead-time for manufacture or fabrication.
 - 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."
- B. Time Frame: Extend schedule from date established for Contract Approval to date of Final Completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 - 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - 3. Submittal Review Time: Include review and resubmittal times indicated in Division 1 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
 - 4. Startup and Testing Time: Include not less than 15 days for startup and testing.
 - 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.

6. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 1 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 1 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 6. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Uninterruptible services.
 - b. Seasonal variations.
 - c. Environmental control.
 7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Startup and placement into final use and operation.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Contract Approval, Substantial Completion, and Final Completion, and the following interim milestones:
1. Temporary enclosure and space conditioning.
- F. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
1. Refer Section 01 29 00 "Payment Procedures" for cost reporting and payment procedures.
 2. Contractor shall assign cost to construction activities on the CPM schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with Architect's approval, be assigned to fabrication and delivery activities. Costs shall be under required principal subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
 3. Each activity cost shall reflect an accurate value subject to approval by Architect.
 4. Total cost assigned to activities shall equal the total Contract Sum.
- G. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragments to demonstrate the effect of the proposed change on the overall project schedule.

2.3 PRELIMINARY CONSTRUCTION SCHEDULE

- A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within 14 days of date established for the Contract Approval.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. CPM Schedule: Prepare Contractor's Construction Schedule using a time-scaled CPM network analysis diagram for the Work.
 - 1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for the Contract Approval.
 - a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.
 - 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 - 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 - 4. Use "one workday" as the unit of time. Include list of nonworking days and holidays incorporated into the schedule.
- C. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.
 - 1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing
 - j. Commissioning.
 - 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 - 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 - 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Sub-networks on separate sheets are permissible for activities clearly off the critical path.
- D. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:
 - 1. Contractor or subcontractor and the Work or activity.
 - 2. Description of activity.
 - 3. Principal events of activity.

4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the Schedule of Values).
- E. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.
- F. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.5 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Material deliveries.
 5. High and low temperatures and general weather conditions.
 6. Accidents.
 7. Meetings and significant decisions.
 8. Unusual events (refer to special reports).
 9. Stoppages, delays, shortages, and losses.
 10. Meter readings and similar recordings.
 11. Emergency procedures.
 12. Orders and requests of authorities having jurisdiction.
 13. Change Orders received and implemented.
 14. Change Directives received and implemented.
 15. Services connected and disconnected.
 16. Equipment or system tests and startups.
 17. Partial Completions and occupancies.
 18. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported

plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.

- C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for interpretation. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.6 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, and response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 - 3. As the Work progresses, indicate Actual Completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Architect and Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 32 10 PROJECT SCHEDULE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes
 - 1. Outline Schedule
 - 2. Projected Schedule
- B. Related Sections
 - 1. Section 01 32 00 – Construction Progress Documentation – Requirements for development and maintenance of schedule

1.3 OUTLINE SCHEDULE

- A. Project is anticipated to consist of one phase.
- B. All Bidders are to expedite construction so as to meet the project completion date.
- C. Float time allowance shall be deemed to include 14 calendar days outside the critical path time line.
 - 1. Float or slack time within the contract time period is not for the exclusive use or benefit of the Owner or the Contractor, but is a resource available to both parties as needed to meet the completion date of the contract.
 - 2. Pursuant to these float sharing requirements, no time extensions will be granted until a delay occurs which impacts the project's critical path, consumes all available float or contingency time available and extends the Work beyond the completion date of the contract.

1.4 PROJECTED SCHEDULE

- A. The building construction project consists of one phase:
 - 1. The Library will relocate its operations throughout the entire project.
 - 2. The outline schedule represents the maximum acceptable timeframe for completing the project and its component phases. Alternate schedules that compress the timeframe are acceptable within the following parameters:

a. Contract Approval	January 20, 2025
b. Construction Start	February 1, 2025
c. Substantial Completion	February 1, 2026

PART 2 - PRODUCTS – NOT USED.

PART 3 - EXECUTION – NOT USED.

END OF SECTION 01 32 10

SECTION 01 33 00 SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Architect's responsive action.
- B. Informational Submittals: Written information that does not require Architect's responsive action. Submittals may be rejected for not complying with requirements.
- C. Coordination Drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.
 - 1. Preparation of Coordination Drawings is specified in Division 1 Section "Coordination" and may include components previously shown in detail on Shop Drawings or Product Data.
- D. Field samples are full-size physical examples erected on-site to illustrate finishes, coatings, or finish materials. Field samples are used to establish the standard by which the Work will be judged.
- E. Mockups are full-size assemblies for review of construction, coordination, testing, or operation; they are not Samples.
- F. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- G. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 SUBMITTAL PROCEDURES

- A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals.
 - 1. Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and Project record drawings.

- a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Digital Drawing Software Program: The Contract Drawings are available in Autodesk AutoCAD, upon request.
 - c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.
 - d. The following digital data files will be furnished upon request:
 - 1) Architectural Floor plans.
 - 2) Architectural Reflected ceiling plans.
 - e. Limitations: Available files are limited to files that already exist, in the software listed above as drawn by the designer, without incorporating modifications after "Issue for Bid."
- B. Submittals Schedule: Comply with requirements in Section 01 32 00 "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - a. The Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.
- D. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
- E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number and revision identifier.

- a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., CPL-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect and Construction Manager.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Contractor.
 - e. Name of firm or entity that prepared submittal.
 - f. Names of subcontractor, manufacturer, and supplier.
 - g. Category and type of submittal.
 - h. Submittal purpose and description.
 - i. Specification Section number and title.
 - j. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.
 - n. Indication of full or partial submittal.
 - o. Submittal distribution record.
 - p. Other necessary identification.
 - q. Remarks.
5. Metadata: Include the following information as keywords in the electronic submittal file metadata:
 - a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- F. Resubmittals: Make resubmittals in same format.
 1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked "Reviewed with No Comments" or "Reviewed with Comments".
- G. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- H. Use for Construction: Use only final submittals with mark indicating "Reviewed with No Comments" or "Reviewed with Comments" as action taken by Architect.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Submit electronic submittals via email as PDF electronic files.
 - a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

2.2 PRODUCT DATA:

- A. Collect product data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.
1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each 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. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Compliance with specified referenced standards.
 - f. Testing by recognized testing agency.
 - g. Application of testing agency labels and seals.
 - h. Notation of coordination requirements.
 - i. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 - j. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 5. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
 6. Submit PDF electronic file.
 7. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.
 - a. Do not proceed with installation until a copy of Product Data is in the Installer's possession.
 - b. Do not permit use of unmarked copies of Product Data in connection with construction.

2.3 SHOP DRAWINGS

- A. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.
- B. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates and similar Drawings. Include the following information:
 - 1. Preparation
 - a. Identification of products and materials included by sheet and detail number.
 - b. Drawings shall be to scale with dimensions.
 - c. Compliance with specified standards.
 - d. Fabrication and installation drawings.
 - e. Notation of coordination requirements.
 - f. Notation of dimensions established by field measurement.
 - g. Relationship to adjoining construction clearly indicated.
 - h. Seal and signature of professional engineer if specified.
 - 2. Submit Shop Drawings as a PDF electronic file.

2.4 SAMPLES

- A. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
 - 1. Mount or display Samples in the manner to facilitate review of qualities indicated. Prepare samples to match the Architect's sample. Include the following:
 - a. Specification Section number and reference.
 - b. Generic description of the Sample.
 - c. Product name and name of the manufacturer.
 - d. Sample source.
 - e. Compliance with recognized standards.
 - f. Availability and delivery time.
 - 2. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 - 3. Submit Samples for review of size, kind, color, pattern, and texture. Submit Samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
 - a. Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least 3 multiple units that show approximate limits of the variations.
 - b. Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
 - c. Samples not incorporated into the Work, or otherwise designated as the Owner's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.
 - 4. Submittals: Except for Samples illustrating assembly details, workmanship, fabrication techniques, connections, operation, and similar characteristics, submit 3 sets. The Architect will return one set marked with the action taken.

5. Maintain sets of Samples, as returned, at the Project Site, for quality comparisons throughout the course of construction.
 - a. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
 - b. Sample sets may be used to obtain final acceptance of the construction associated with each set.
- B. Distribution of Samples: Prepare and distribute additional sets to subcontractors, manufacturers, fabricators, suppliers, installers, and others as required for performance of the Work. Show distribution on transmittal forms.
 1. Field samples are full-size examples erected on-site to illustrate finishes, coatings, or finish materials and to establish the Project standard.
 - a. Comply with submittal requirements to the fullest extent possible. Process transmittal forms to provide a record of activity.

2.5 OTHER ACTION SUBMITTALS

- A. Submittals Schedule: Comply with requirements specified in Section 01 30 00 "Construction Progress Documentation".
- B. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 "Payment Procedures."
- C. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 2. Number and title of related Specification Section(s) covered by subcontract.
 3. Drawing number and detail references, as appropriate, covered by subcontract.
 - a. Mark up and retain one returned copy as a Project Record Document.
- D. Coordination Drawing Submittals: Comply with requirements specified in Section 01 31 00 "Project Management and Coordination."
- E. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."
- F. Product Schedule or List: 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.
 2. Number and name of room or space.
 3. Location within room or space.
 4. Submit product schedule as a PDF electronic file.

2.6 INFORMATIONAL SUBMITTALS

- A. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00 "Quality Requirements."
- B. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."
- C. Maintenance Data: Comply with requirements specified in Section 01 78 23 "Operation and Maintenance Data."

- D. 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.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- G. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- H. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- I. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- J. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- K. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- L. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- M. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- N. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

- O. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- P. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.7 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 77 00 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

- A. Action Submittals; Architect will review each submittal, make marks to indicate corrections or revisions required, stamp and return it promptly.
 - 1. Compliance with specified characteristics is the Contractor's responsibility.
- B. Action Stamp: The Architect will stamp each submittal with a uniform, action stamp. The Architect will mark the stamp appropriately to indicate the action taken, as follows:
 - 1. Final Unrestricted Release: When the Architect marks a submittal "Reviewed Without Comment," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.
 - 2. Final-But-Restricted Release: When the Architect marks a submittal "Reviewed With Comments," the Work covered by the submittal may proceed provided it complies with notations or

- corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.
3. Returned for Resubmittal: When the Architect marks a submittal "Revise and Resubmit," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
 - a. Do not use, or allow others to use, submittals marked "Revise and Resubmit" at the Project Site or elsewhere where Work is in progress.
 4. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the Architect will return the submittal marked "Action Not Required."
- C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 01 33 00

SECTION 01 40 00 QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- C. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
- D. Pre-construction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.

- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- J. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of 5 previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

- A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.

13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
 - C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.6 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 1. Requirement for specialists shall not supersede building codes and regulations governing the Work.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and

with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work.
1. Comply with requirements specified in individual Sections in Divisions 2 through 16.
 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 3. Demolish and remove mockups when directed unless otherwise indicated.

1.7 QUALITY CONTROL

- A. Contractor Responsibilities: Tests and inspections are the Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- B. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."
- C. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

- D. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- E. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 - 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform any duties of Contractor.
- F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION

3.1 QUALITY ASSURANCE/CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply fully with manufacturer's instructions, including each step in sequence.
- C. Should manufacturer's instructions conflict with Contract Documents, request clarification from Architect before proceeding.

- D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform work by persons qualified to produce workmanship of specified quality.
- F. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

3.2 REFERENCES

- A. Conform to reference standard cited in specific testing or inspection requirement listed below. If no specific test is cited, conform to most current standard by date of Contract Documents.
- B. Should specified reference standards conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- C. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

3.3 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
- B. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

3.4 CONTRACTOR RESPONSIBILITIES

- A. Contractor Responsibilities: Unless otherwise indicated as the responsibility of another identified entity, Contractor shall provide inspections, tests, and other quality-control services specified elsewhere in the Contract Documents and required by authorities having jurisdiction. Costs for these services are included in the Contract Sum.
 - 1. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the Owner's responsibility, the Owner will employ and pay a qualified independent testing agency to perform those services.
 - a. Where the Owner has engaged a testing agency for testing and inspecting part of the Work, and the Contractor is also required to engage an entity for the same or related element, the Contractor shall not employ the entity engaged by the Owner, unless agreed to in writing by the Owner.
- B. Re-testing: The Contractor is responsible for re-testing where results of inspections, tests, or other quality-control services prove unsatisfactory and indicate noncompliance with Contract Document requirements, regardless of whether the original test was Contractor's responsibility.
 - 1. The cost of re-testing construction, revised or replaced by the Contractor, is the Contractor's responsibility where required tests performed on original construction indicated noncompliance with Contract Document requirements.
- C. Associated Services: 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 include, but are not limited to, the following:

1. Provide access to the Work.
 2. Furnish incidental labor and facilities necessary to facilitate inspections and tests.
 3. Take adequate quantities of representative samples of materials that require testing or assist the agency in taking samples.
 4. Provide facilities for storage and curing of test samples.
 5. Deliver samples to testing laboratories.
 6. Provide the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.
 7. Provide security and protection of samples and test equipment at the Project Site.
- D. Coordination: Coordinate the sequence of activities to accommodate required services with a minimum of delay. Coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests.
1. The Contractor is responsible for scheduling times for inspections, tests, taking samples, and similar activities.

END OF SECTION 01 40 00

SECTION 01 50 00 TEMPORARY FACILITIES

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 requirements for temporary protection measures.

1.3 INFORMATIONAL SUBMITTALS

- A. 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. Identify further options if proposed measures are later determined to be inadequate. Include the following:
 - 1. HVAC system isolation schematic drawing.
 - 2. Location of proposed air-filtration system discharge.
 - 3. Waste handling procedures.
 - 4. Other dust-control measures.

PART 2 - PRODUCTS

2.1 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: Provide mats minimum 36 by 60 inches.

2.2 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Isolation of Work Areas: Prevent dust, fumes, and odors.
 - 1. Prior to commencing work:
 - a. Disconnect supply and return ductwork in work area from HVAC systems which will serve occupied areas.

- b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of construction, and continuing until construction is substantially complete.
- 2. Use vacuum collection attachments on dust-producing equipment.
- 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- B. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration.
 - 1. Protect air-handling equipment.
 - 2. Provide walk-off mats at each entrance through temporary partition.
- C. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

3.2 OPERATION, TERMINATION, AND REMOVAL

- A. Maintenance: Maintain facilities in good operating condition until removal.
- B. Termination and Removal: Remove each temporary facility when need for its service has ended. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

END OF SECTION 01 50 00

SECTION 01 60 00 PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for selection of products for use in Project;
 - 1. Product delivery, storage, and handling;
 - 2. Manufacturers' standard warranties on products; special warranties;
 - 3. Product substitutions.

1.3 DEFINITIONS

- A. Definitions used in this Article are not intended to change the meaning of other terms used in the Contract Documents, such as "specialties," "systems," "structure," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.
- B. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
 - 4. Materials: Products that are substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.
 - 5. Equipment: Products with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.
- D. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1.4 SUBSTITUTION REQUESTS:

- A. Submit request for substitution for all proposed substitutions. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Substitution Request Form: Use form provided at end of Section.
 2. Documentation: Show compliance with requirements for substitutions including and the following, as applicable:
 - a. Statement indicating why specified material or product cannot be provided.
 - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures side by side to that of the specified product.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
 - j. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
 - n. All of the above should be specific to this project; including a full brochure or link to a website, without specifically highlighting points to be considered will be grounds for rejection of the Substitution Request.
- B. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
1. Form of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 2. Use product specified if Architect cannot make a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

- A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.
1. When specified products are available only from sources that do not, or cannot, produce a quantity adequate to complete project requirements in a timely manner, consult with the Architect to determine the most important product qualities before proceeding. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to the fullest extent possible.
- B. Compatibility of Options: When the Contractor is given the option of selecting between two or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.
1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.
- C. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products that will be exposed to view in occupied spaces or on the exterior.
1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 1 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, new at the time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, safety guards, and other devices and details needed for a complete installation and the intended use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
 6. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," the product should be submitted using the Substitution Request form and procedure outlined above. Architect's decision will be final on whether a proposed product is equal.
- B. Product Selection Procedures:
1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
 3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
 4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
 5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 1 "Substitution Requests" Article for consideration of an unnamed product.
 6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 1 "Substitution Requests" Article for consideration of an unnamed product.
 7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 1 "Substitution Requests" Article for consideration of an unnamed product or system.
 8. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 1 "Substitution Requests" Article for consideration of an unnamed product by the other named manufacturers.
- C. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 1 "Substitution Requests" Article for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.

1. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
2. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.
3. Samples, if requested.

2.2 PRODUCT SUBSTITUTIONS

- A. Timing: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.
- B. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 2. Requested substitution does not require extensive revisions to the Contract Documents.
 3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 4. Substitution request is fully documented and properly submitted.
 5. Requested substitution will not adversely affect Contractor's Construction Schedule.
 6. Requested substitution has received necessary approvals of authorities having jurisdiction.
 7. Requested substitution is compatible with other portions of the Work.
 8. Requested substitution has been coordinated with other portions of the Work.
 9. Requested substitution provides specified warranty.
 10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION

3.1 SUBSTITUTION REQUEST FORM

- A. Substitution Request form is appended to this section.

SEE NEXT PAGE FOR SUBSTITUTION REQUEST FORM

SUBSTITUTION REQUEST FORM

Project: _____

We hereby submit for your consideration the following product instead of the specified item for the above referenced project:

Section	Paragraph	Specified Item

Proposed Substitution:

Attach complete technical data annotated for relevance to this project, including laboratory tests, if necessary. Include complete information on changes to Drawings and or Specifications which the proposed substitution requires for proper installation.

Fill in the blanks below. Use additional sheets if necessary.

A. Does the proposed substitution affect dimensions shown on the Drawings?

B. Will the undersigned pay for changes to the building design, including engineering and detailing costs caused by the proposed substitution, if any?

C. What effect does the proposed substitution have on other trades?

D. What are the differences between the proposed substitution and the specified item?

E. What are the differences in the Manufacturer's Warranties between the proposed substitution and the specified item?

The undersigned states that the function, appearance and quality of the proposed substitution are equivalent or superior to the specified item. The undersigned acknowledges that acceptance of the proposed substitution is entirely at the Architect's discretion.

Signature _____
Name _____
Firm: _____
Address: _____
Telephone _____

For Architect's Use:	
<input type="checkbox"/> Accepted	<input type="checkbox"/> Accepted As Noted
<input type="checkbox"/> Not Accepted	<input type="checkbox"/> Received Too Late
By: _____	
Date _____	

END OF SECTION 01 60 00

SECTION 01 73 00 EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
 1. Construction layout.
 2. Field engineering and surveying.
 3. Installation of the Work.
 4. Coordination of Owner-installed products.
 5. Progress cleaning.
 6. Starting and adjusting.
 7. Protection of installed construction.
 8. Correction of the Work.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of construction indicated as existing are not guaranteed. Before beginning work verify the existence and location of other construction affecting the Work.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 1. Description of the Work.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. **Field Measurements:** Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. **Space Requirements:** Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. **Review of Contract Documents and Field Conditions:** Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 INSTALLATION

- A. **General:** Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of 8 feet in spaces without a suspended ceiling.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. **Tools and Equipment:** Do not use tools or equipment that produce harmful noise levels.
- F. **Templates:** Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. **Attachment:** Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - 1. **Mounting Heights:** Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. 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.
- H. **Joints:** Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- I. **Hazardous Materials:** Use products, cleaners, and installation materials that are not considered hazardous.

3.4 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project work area for Owner's construction forces.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces.
 - 1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 - 2. Pre-installation Conferences: Include Owner's construction forces at pre-installation conferences covering portions of the Work that are to receive Owner's work. Attend pre-installation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

3.5 PROGRESS CLEANING

- A. This Article refers to regular cleaning operations conducted while construction is in progress. Requirements for final cleaning before Substantial Completion are included in Division 1 Section "Closeout Procedures."
- B. General: Clean Project work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - 3. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.6 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.7 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.8 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01 73 00

SECTION 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

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 administrative and procedural requirements for the following:
 - 1. Salvaging non-hazardous construction waste.
 - 2. Recycling non-hazardous construction waste.
 - 3. Disposing of non-hazardous construction waste.

1.3 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Disposal Sites, Recyclers, and Waste Materials Processors: Use only facilities properly permitted by state and local authorities.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 IMPLEMENTATION

- A. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Section 01 50 00 "Temporary Facilities and Controls."
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
 2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle construction materials and beverage containers to the greatest extent possible.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
 1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 3. Store components off the ground and protect from the weather.
 4. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

3.3 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Burning of waste materials is not permitted.
- C. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION 01 74 19

SECTION 01 77 00 CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
 - 5. Repair of the Work.

1.3 ACTION SUBMITTALS

- A. Product Data: For cleaning agents.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Construction Manager. Label with manufacturer's name and model number where applicable.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Construction Manager's signature for receipt of submittals.
 5. Submit test/adjust/balance records.
 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 3. Complete startup and testing of systems and equipment.
 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 6. Advise Owner of changeover in heat and other utilities.
 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements, including touchup painting.
 10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect and Owner will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for final completion.

1.7 FINAL ACCEPTANCE

- A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.
 2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
 3. Submit a certified copy of the Architect's final inspection list of items to be completed or corrected, endorsed and dated by the Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by the Architect.
 4. Submit consent of surety to final payment.
 5. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 6. Submit pest-control final inspection report and warranty.
 7. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
 8. Submit demonstration and training videotapes.
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
- C. Reinspection Procedure: The Architect will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the Architect.
1. Upon completion of reinspection, the Architect will prepare a certificate of final acceptance. If the Work is incomplete, the Architect will advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
 2. If necessary, reinspection will be repeated at Contractor's expense.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Page number.
 4. Submit list of incomplete items in the following format:
 - a. MS Excel electronic file. Architect, will return annotated file.

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
 - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
 - 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - b. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

- c. Sweep concrete floors broom clean in unoccupied spaces.
 - d. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
 - e. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - f. Remove labels that are not permanent.
 - g. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - h. Leave Project clean and ready for occupancy.
- C. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
- 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 - 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 01 77 00

SECTION 01 78 23 OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Operation manuals for systems, subsystems, and equipment.
 - 3. Product maintenance manuals.
 - 4. Systems and equipment maintenance manuals.

1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect and Commissioning Authority will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
 - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
 - 2. One paper copy. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Architect, will hand over copy to Owner once approved.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.

- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return copy with comments.
 - 1. Correct or revise each manual to comply with Architect's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.

1.5 COORDINATION

- A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:
 - 1. List of documents.
 - 2. List of systems.
 - 3. List of equipment.
 - 4. Table of contents.
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 REQUIREMENTS FOR OPERATION, AND MAINTENANCE MANUALS

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.

- B. Title Page: Include the following information:
1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Architect.
 7. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 8. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- F. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Supplementary Text: Prepared on white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
 1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
 1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.

- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

2.4 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

- C. **Manufacturers' Maintenance Documentation:** Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.

- D. **Maintenance Procedures:** Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.

- E. **Maintenance and Service Schedules:** Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. **Scheduled Maintenance and Service:** Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. **Maintenance and Service Record:** Include manufacturers' forms for recording maintenance.

- F. **Spare Parts List and Source Information:** Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

- G. **Maintenance Service Contracts:** Include copies of maintenance agreements with name and telephone number of service agent.

- H. **Warranties and Bonds:** Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. **Operation and Maintenance Documentation Directory:** Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

- B. **Product Maintenance Manual:** Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

- C. **Operation and Maintenance Manuals:** Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
1. Do not use original Project Record Documents as part of operation and maintenance manuals.
 2. Comply with requirements of newly prepared Record Drawings in Division 1 Section "Project Record Documents."
- F. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

SECTION 01 78 39 PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.

1.3 SUBMITTALS

- A. Record Drawings: Submit 1 set of marked-up Record Prints.
- B. Record Specifications: Submit 1 copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit 1 copy.
 - 1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in manual instead of submittal as Record Product Data.
- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit one paper copy of each submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.

2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made following Architect's written orders.
 - k. Details not on the original Contract Drawings.
 - l. Field records for variable and concealed conditions.
 - m. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing Record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
 2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared Record Drawings into Record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect and Construction Manager.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
 5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as a paper copy.
1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's and Construction Manager's reference during normal working hours.

END OF SECTION 01 78 39

**SECTION 02 41 00
DEMOLITION**

PART 1 GENERAL

1.01 QUALITY ASSURANCE

- A Demolition Firm Qualifications: Company specializing in the type of work required.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
- B Do not begin removal until built elements to be salvaged or relocated have been removed.
- C Minimize production of dust due to demolition operations. Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- D Hazardous Materials:
 - 1. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCBs, and mercury.
- E Perform demolition in a manner that maximizes salvage and recycling of materials.

3.02 EXISTING UTILITIES

- A Coordinate work with utility companies. Notify utilities before starting work, comply with their requirements, and obtain required permits.
- B Protect existing utilities to remain from damage.

3.03 SELECTIVE DEMOLITION FOR ALTERATIONS

- A Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
- B Maintain weatherproof exterior building enclosure, except for interruptions required for replacement or modifications; prevent water and humidity damage.
- C Remove existing work as indicated and required to accomplish new work.
- D Services including, but not limited to, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications: Remove existing systems and equipment as indicated.
- E Protect existing work to remain.

3.04 DEBRIS AND WASTE REMOVAL

- A Remove debris, junk, and trash from site.

END OF SECTION 02 41 00

SECTION 02 41 13 SITE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

- A. Site Demolition is the work necessary to remove buildings, foundations, walls, or other structures; concrete slabs, pavements, walks or curbs; concrete bases, signs, abandoned utility structures, and all other items indicated for removal on the Plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. If the removal work leaves a void or hole (e.g. basements) and is not to be included in a subsequent excavating or embankment operation, backfill with suitable material from excavation or granular backfill if specified.

PART 3 - EXECUTION

3.01 SITE DEMOLITION

- A. Perform site demolition work prior to grading operations in order to clear the site for the excavation work. Prior to removal review with Engineer all demolition items.
- B. Concrete Pavements, Walks, Slabs and Curb and Gutter
 - 1. Complete removals in a manner that will not damage adjacent structures that are to remain in place. Use sawcuts, drill lift holes, and use whatever other methods necessary to protect adjacent structures. Following removal of the concrete items, provide temporary ramping if pedestrian or vehicular traffic will use the area. The ramping may be by placement of base course material, wood ramps for pedestrians, or any other method approved by the Engineer.
- C. Concrete Bases
 - 1. Remove concrete bases (sign bases, utility pole bases, etc.) entirely and any resulting openings backfilled.
- D. Walls, Foundations, Piers
 - 1. Remove walls, foundations, piers and similar structures entirely or break down within the area of the proposed work to an elevation that is at least two feet below the earth subgrade for roads, three feet from other proposed facilities, or as indicated on the Plans. No remnant walls, foundations, piers or similar structures may remain in utility trenches or routes.
 - 2. For basement foundations and floor slabs that are allowed to remain, break at least ten percent of the floor area to permit drainage. Backfill all basements and other similar voids to the level of the natural ground, proposed finished subgrade or finished slopes.

E. Buildings

1. Complete building removal in a safe manner and in compliance with state, federal and local regulations, particularly those regulating the handling and disposal of asbestos, lead paint and other hazardous substances. The Owner assumes no responsibility for the condition of any building at any time, and no guarantee is made or implied that any building will remain in the condition the bidder finds it at the time the bidder examines it incidental to preparing the proposal.

3.02 DISPOSING OF MATERIALS

- A. Remove all material designated for salvage carefully to avoid damage and neatly store in an area that will not interfere with the remaining construction. Relics, antiques, cornerstones and contents, commemorative plaques and tablets, and other items remain the property of the Owner.
- B. Recycle all materials that are not salvaged or if recycle options are not available dispose in accordance with all applicable regulations.
- C. Mitigate all hazardous conditions created during removal operations in order to protect the public, Owner, Engineer, and all others that may potentially be exposed to the hazard. Complete all such mitigation work including the design, installation and removal.

3.03 METHOD OF MEASUREMENT, BASIS OF PAYMENT

- A. If a unit price bid item is used for the demolition effort or if payment for this effort is itemized in some other manner by the agreement, measure work in accordance with the applicable bid items. Slabs, pavements, and other flat work may be measured by the square yard removed or lump sum. Curb and Gutter may be measured by the lineal foot removed or lump sum. Buildings and other miscellaneous structures may be measured by the each item or by lump sum. If no specific bid items are listed for items necessary to be removed, all removal work is considered incidental to the project. The payment for demolition work is for all work associated including dismantling, crushing, blasting, sawcutting, hauling, disposal, permitting, planning, backfilling, and other related work not covered by a separate bid item.

END OF SECTION 02 41 13

SECTION 04 01 40.62 BRICK MASONRY and REPOINTING

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. Base Bid Scope:
 - 1. Demolition and Salvage
 - a. Remove Chimney at the West Elevation, complete.
 - b. Clean and salvage face brick for possible reuse as replacement brick where applicable.
 - 2. Repoint:
 - a. Assume 20% of the overall exterior wall area to be repointed including replacement of damaged or deteriorated mortar with historically correct mortar.
 - b. Repoint 600 square feet of deteriorated face brick at the interior face of the masonry foundation wall.
 - 3. Remove and Replace:
 - a. Remove and replace 800 square feet (5%) of deteriorated face brick, replace with matching standard size face brick.
 - b. Construct new brick pier at center of north elevations shown in Drawings.
 - c. Remove and replace 300 square feet of deteriorated face brick at the interior face of the masonry foundation wall.
 - 4. Construct New:
 - a. Construct new brick pier at center of north elevations shown in Drawings.
- B. Provide Unit Pricing:
 - 1. For Repointing of existing masonry, should additional quantities be needed. Unit price to consider 100 square foot increments.
 - 2. For Remove and Replace of existing masonry, should additional quantities be needed. Unit price to consider 100 square foot increments.

1.3 DEFINITIONS

- A. Rift: The most pronounced direction of splitting or cleavage of a brick.

1.4 PLANNING CONFERENCE

- A. Planning Conference: Conduct conference at Project site.
 - 1. Meet at the project site to review the condition of the existing masonry and determine the areas to be repointed. Meeting shall include general contractor, masonry contractor, owner and architect.
 - 2. Document findings on building elevations and basement wall investigations.
 - 3. Review methods and procedures related to repointing brickwork including, but not limited to, the following:
 - a. Verify Mason and brick repointing specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Quality-control program.

- c. Quality-control program.
- d. Coordination with building occupants.

1.5 SEQUENCING and SCHEDULING of REPOINTING

- A. Order sand and gray portland cement for pointing mortar immediately after approval of Samples. Take delivery of and store at Project site enough quantity to complete Project.
- B. Work Sequence: Perform brick repointing work in the following sequence, which includes work specified in this and other Sections:

Exterior:

1. Remove plant growth.
2. Inspect masonry for open mortar joints and permanently or temporarily point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint, if any.
4. Clean brick.
5. Rake out mortar from joints surrounding brick to be replaced and from joints adjacent to brick repairs along joints.
6. Repair brickwork, including replacing existing brick with new or salvaged brick.
7. Rake out mortar from joints to be repointed.
8. Point mortar and sealant joints.
9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.

Interior:

1. Remove furring, etc. as noted on plans to expose brick. Dispose of removed items.
2. Inspect masonry for open mortar joints and permanently or temporarily point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint, if any.
4. Clean brick.
5. Rake out mortar from joints surrounding brick to be replaced and from joints adjacent to brick repairs along joints.
6. Repair brickwork, including replacing existing brick with new or salvaged brick as needed.
7. Rake out mortar from joints to be repointed.
8. Point mortar and sealant joints.
9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include material descriptions, dimensions of individual components and profiles, and finishes.
 2. Include recommendations for product application and use.
 3. Include test data substantiating that products comply with requirements.
- B. Shop Drawings:
 1. Include plans, elevations, sections, construction details and locations of repointing work on the structure.

2. Show provisions for expansion joints or other sealant joints.
 3. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.
 4. Show details including ladders, reinforcement and ties for New Pier Construction.
- C. Samples for Initial Selection: For the following:
1. Pointing Mortar: Submit sets of mortar for pointing in the form of sample mortar strips, 6 inches long and width to match existing, set in aluminum or plastic channels.
 - a. Have each set contain a close color range of at least three Samples of different mixes of colored sands and cements that produce a mortar matching the existing, cleaned mortar when cured and dry.
 - b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.
 2. Sand Type Used for Pointing Mortar: Minimum 8 oz. of each in plastic screw-top jars.
 3. Sealant materials.
 4. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For the following:
1. Brick for Replacement and New Construction.
 2. Provide multiple sample boards for Architect's selection of Standard Face Brick considered a "match" for existing.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For brick repointing specialist.
- B. Preconstruction Test Reports: For existing brick and mortar.
- C. Quality-control program.

1.8 QUALITY ASSURANCE

- A. Brick Repointing Specialist Qualifications: Engage an experienced brick repointing firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing standard unit masonry or new brick masonry is insufficient experience for brick repointing work.
 1. Field Supervision: Brick repointing specialist firms shall maintain experienced full-time supervisors on Project site during times that brick repointing work is in progress.
- B. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging brickwork. Include provisions for supervising performance and preventing damage.
- C. Mockups: Prepare mockups of brick repointing to demonstrate aesthetic effects and to set quality standards for materials and execution.
 1. Repointing: Rake out joints in two separate areas, each approximately 36 inches high by 48 inches wide for each type of repointing required, and repoint one of the areas.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on brick units as follows:
 1. Provide test specimens as indicated and representative of proposed materials and existing construction.
 2. Existing Mortar: Test according to ASTM C1324, modified as agreed by testing service and Architect for Project requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength.
 3. Temporary Patch: As directed by Architect, provide temporary materials followed by permanent repairs at locations from which existing samples were taken.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
- D. Store sand where grading and other required characteristics can be maintained and contamination avoided.

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit repointing work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Temperature Limits: Repoint mortar joints only when air temperature is between 40 and 90 deg F and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.
- C. Cold-Weather Requirements: Comply with the following procedures for mortar-joint pointing unless otherwise indicated:
 1. When air temperature is below 40 deg F, heat mortar ingredients and existing brick to produce temperatures between 40 and 120 deg F.
 2. When mean daily air temperature is below 40 deg F, provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for seven days after pointing.
- D. Hot-Weather Requirements: Protect mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F and above unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Source Limitations: Obtain each type of material for brick repointing (cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; white or gray, or both where required for color matching of mortar.
 - 1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Masonry Cement: ASTM C91/C91M.
- D. Mortar Cement: ASTM C1329/C1329M.
- E. Mortar Sand: ASTM C144.
 - 1. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
 - 2. Color: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.
- F. Mortar Pigments: ASTM C979/C979M, compounded for use in mortar mixes, and having a record of satisfactory performance in brick mortars.
- G. Water: Potable.

2.3 ACCESSORY MATERIALS

- A. Sealant Materials:
 - 1. Sealant manufacturer's standard elastomeric sealant(s) of base polymer and characteristics indicated below and according to applicable requirements in Section 07 92 00 "Joint Sealants."
 - a. Type: Single-component, non-sag urethane sealant.
 - 2. Colors: Provide colors of exposed sealants to match colors of mortar adjoining installed sealant unless otherwise indicated.
 - 3. Ground-Mortar Aggregate: Custom crushed and ground pointing mortar sand or existing mortar retrieved from joints. Grind to a particle size that matches the adjacent mortar aggregate and color. Remove all fines passing the No. 100 sieve.
- B. Joint-Sealant Backing: See Section 07 92 00 "Joint Sealants".
- C. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.
- D. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 - 1. Previous effectiveness in performing the work involved.
 - 2. Minimal possibility of damaging exposed surfaces.
 - 3. Consistency of each application.
 - 4. Uniformity of the resulting overall appearance.
 - 5. Do not use products or tools that could leave residue on surfaces.

2.4 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
- B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's approval.
 - 1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.
- C. Do not use admixtures in mortar unless otherwise indicated.
- D. Mixes: Mix mortar materials in the following proportions:
 - 1. Pointing Mortar by Type: ASTM C270, Proportion Specification, Type N unless otherwise indicated. Provide pointing mortar mixed to match Architect's sample and complying with the following:
 - a. Packaged Portland Cement-Lime Mix Mortar: Use Portland cement-lime mix of selected color.
 - b. Point brick with Type N mortar.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Prevent mortar from staining face of surrounding brick and other surfaces.
 - 1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
 - 2. Keep wall area wet below pointing work to discourage mortar from adhering.
 - 3. Immediately remove mortar splatters in contact with exposed brick and other surfaces.
- B. Remove downspouts and associated hardware adjacent to brick and store during brick repointing. Reinstall when repointing is complete.
 - 1. Provide temporary rain drainage during work to direct water away from building.

3.2 BRICK REPOINTING, GENERAL

- A. Appearance Standard: Repointed surfaces are to have a uniform appearance as viewed from 20 feet away by Architect.

3.3 REPOINTING

- A. Rake out and repoint joints to the following extent:
 - 1. All joints in areas indicated.
 - 2. Joints indicated as sealant-filled joints.
 - 3. Joints at locations of the following defects:
 - a. Holes and missing mortar.
 - b. Cracks that can be penetrated 1/4 inch or more by a knife blade 0.027 inch thick.
 - c. Cracks 1/8 inch or more in width and of any depth.
 - d. Hollow-sounding joints when tapped by metal object.
 - e. Eroded surfaces 1/4 inch or more deep.

- f. Deterioration to point that mortar can be easily removed by hand, without tools.
 - g. Joints filled with substances other than mortar.
- B. Do not rake out and repoint joints where not required.
- C. Rake out joints as follows, according to procedures demonstrated in approved mockup:
 - 1. Remove mortar from joints to depth of joint width plus 1/8 inch and not less than that required to expose sound, unweathered mortar. Do not remove unsound mortar more than 2 inches deep; consult Architect for direction.
 - 2. Remove mortar from brick surfaces within raked-out joints to provide reveals with square backs and to expose brick for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
 - 3. Do not spall edges of brick units or widen joints. Replace or patch damaged brick units as directed by Architect.
- D. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose brick, rotted wood, rusted metal, and other deteriorated items.
- E. Pointing with Mortar:
 - 1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
 - 2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch until a uniform depth is formed. Fully compact each layer, and allow it to become thumbprint hard before applying next layer.
 - 3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than 3/8 inch. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing brick has worn or rounded edges, slightly recess finished mortar surface below face of brick to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed brick surfaces or to feather-edge the mortar.
 - 4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
 - 5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.
 - 6. Hairline cracking within mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.
- F. Where repointing work precedes cleaning of existing brick, allow mortar to harden at least 30 days before beginning cleaning work.

3.4 FINAL CLEANING

- A. After mortar has fully hardened, thoroughly clean exposed brick surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water, applied by low-pressure spray.
 - 1. Do not use metal scrapers or brushes.
 - 2. Do not use acidic or alkaline cleaners.

END OF SECTION 04 01 40.62

SECTION 04 22 00 CONCRETE MASONRY UNIT

PART 1 - GENERAL

1.1 SUMMARY

Section Includes:

1. Concrete masonry units.
2. Steel reinforcing bars.

1.2 DEFINITIONS

CMU(s): Concrete masonry unit(s).

Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 ACTION SUBMITTALS

Product Data: For each type of product.

Shop Drawings: For reinforcing steel. Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.

Samples: For each type and color of the following:

1. Pigmented and colored-aggregate mortar.

1.4 INFORMATIONAL SUBMITTALS

Material Certificates: For each type and size of product. For masonry units, include data on material properties and material test reports substantiating compliance with requirements.

Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

1.5 QUALITY ASSURANCE

Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for typical exterior and interior walls in sizes approximately 48 inches long by 36 inches high by full thickness.

1.6 FIELD CONDITIONS

Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

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

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

Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

Integral Water Repellent: Provide units made with integral water repellent for exposed units and where indicated.

CMUs: ASTM C90.

2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3250 psi.
3. Density Classification: Normal weight unless otherwise indicated.

Concrete Building Brick: ASTM C55.

4. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3250 psi.
5. Density Classification: Normal weight.

2.3 MORTAR AND GROUT MATERIALS

Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

Hydrated Lime: ASTM C207, Type S.

Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

Masonry Cement: ASTM C91/C91M.

Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

Colored Cement Products: Packaged blend made from portland cement and hydrated lime or masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

- a. Submit manufacturer name and product for approval prior to use.
2. Colored Masonry Cement:
 - a. Submit manufacturer name and product for approval prior to use.

Aggregate for Mortar: ASTM C144.

3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

Aggregate for Grout: ASTM C404.

Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

5. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Euclid Chemical Company (The); Accelguard 80.
 - b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
 - c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

6. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ACM Chemistries, Inc.; RainBloc.
 - b. BASF Aktiengesellschaft; Rheopel Plus.
 - c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block

Water: Potable.

2.4 REINFORCEMENT

Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.

Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

Masonry-Joint Reinforcement, General: ASTM A951/A951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized carbon steel.
3. Wire Size for Side Rods: 0.148-inch diameter.
4. Wire Size for Cross Rods: 0.148-inch diameter.
5. Spacing of Cross Rods: Not more than 16 inches o.c.
6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

2.5 TIES AND ANCHORS

Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
3. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

4. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch diameter, hot-dip galvanized-steel wire.
5. Tie Section: Triangular-shaped wire tie made from 0.187-inch diameter, hot-dip galvanized-steel wire.

Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

6. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.060-inch thick steel sheet, galvanized after fabrication.
7. Tie Section: Triangular-shaped wire tie made from 0.187-inch diameter, hot-dip galvanized-steel wire.
8. Corrugated-Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.060-inch thick steel sheet, galvanized after fabrication with dovetail tabs for inserting into dovetail slots in concrete.

2.6 EMBEDDED FLASHING MATERIALS

Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch thick.
2. Copper: ASTM B370, Temper H00, cold-rolled copper sheet, 16-oz./sq. ft. weight or 0.0216 inch thick or ASTM B370, Temper H01, high-yield copper sheet, 12-oz./sq. ft. weight or 0.0162 inch thick.
3. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
4. Fabricate metal drip edges from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
5. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches (76 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
6. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.

Flexible Flashing: Use one of the following unless otherwise indicated:

7. Copper-Laminated Flashing: 7-oz./sq. ft. copper sheet bonded between two layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

8. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.
9. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.040 inch.
10. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) DuPont; Thru-Wall Flashing.
 - 2) Hohmann & Barnard, Inc.; Flex-Flash.
 - 3) Hyload, Inc.; Hyload Cloaked Flashing System.
 - 4) Mortar Net USA, Ltd.; Total Flash.
11. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M, 0.040 inch thick.

Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

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

Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805, or PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.8 MORTAR AND GROUT MIXES

General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime or masonry cement mortar unless otherwise indicated.
3. For exterior masonry, use portland cement-lime mortar.
4. For reinforced masonry, use portland cement-lime mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

6. For masonry below grade or in contact with earth, use Type M.
7. For reinforced masonry, use Type S.
8. For mortar parge coats, use Type S or Type N.
9. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type S or N.
10. For interior nonload-bearing partitions, Type O may be used instead of Type N.

Pigmented Mortar: Use colored cement product.

11. Pigments do not exceed 10 percent of portland cement by weight.
12. Pigments do not exceed 5 percent of masonry cement by weight.
13. Application: Use pigmented mortar for exposed mortar joints with the following units:
 - a. Decorative CMUs.
 - b. Pre-faced CMUs.

Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

14. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:
 - a. Decorative CMUs.
 - b. Pre-faced CMUs.

Grout for Unit Masonry: Comply with ASTM C476.

15. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
16. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2500 psi.
17. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143/C143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 TOLERANCES

Dimensions and Locations of Elements:

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

Lines and Levels:

4. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
5. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
6. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
7. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
8. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.

Joints:

9. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
10. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
11. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.3 LAYING MASONRY WALLS

Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

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

3.4 MORTAR BEDDING AND JOINTING

Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.

2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 MASONRY-JOINT REINFORCEMENT

General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

Provide continuity at wall intersections by using prefabricated T-shaped units.

Provide continuity at corners by using prefabricated L-shaped units.

3.6 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.7 FLASHING

General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.

Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.

4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.

Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

3.8 REINFORCED UNIT MASONRY

Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

3. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
4. Limit height of vertical grout pours to not more than 60 inches.

3.9 FIELD QUALITY CONTROL

Testing and Inspecting: Contractor/CM to engage a testing agency to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

Inspections: Material tests and inspections according to Level B in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

Testing Prior to Construction: One set of tests.

Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.

Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.

Mortar Test (Property Specification): For each mix provided, according to ASTM C780. Test mortar for mortar air content and compressive strength.

Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.

Prism Test: For each type of construction provided, according to ASTM C1314 at seven days and at 28 days.

3.10 PARGING

Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

Damp-cure parging for at least 24 hours and protect parging until cured.

3.11 REPAIRING, POINTING, AND CLEANING

In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.12 MASONRY WASTE DISPOSAL

Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 22 00

SECTION 05 12 00 STRUCTURAL STEEL FRAMING

GENERAL

1.1 SCOPE

- A. Perform all Work required to complete the Structural Metal Framing as indicated by the Contract Documents, and furnish all items necessary for proper installation.

1.2 REFERENCES

- A. American Institute of Steel Construction (AISC)
 - 1. Manual of Steel Construction
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A6, Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.
 - 2. ASTM A36, Standard Specification for Structural Steel.
 - 3. ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - 4. ASTM A108, Specification for Steel Bars, Cold Finished, Standard Quality, Grades 1010 through 1020.
 - 5. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 10,000 PSI Tensile Strength.
 - 6. ASTM F3125 Grade 325, Standard Specification for High-Strength Bolts for Structural Steel Joints.
 - 7. ASTM F3125 Grade 490, Standard Specification for Heat-Treated Steel Structural Bolts, 150 KSI Minimum Tensile Strength.
 - 8. ASTM A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 9. ASTM A992, Standard Specification for Steel for Structural Shapes for Use in Building Framing.
- C. American Welding Society (AWS)
 - 1. AWS D1.1, Structural Welding Code.
- D. Steel Structures Painting Council
 - 1. Painting Manual.

1.3 SUBMITTALS

- A. See DOCUMENT 01 30 00.
 - 1. Submit shop drawings in PDF format indicating the following.
 - a. Type of steel.
 - b. Location and identification mark of each member.
 - c. Dimensions.
 - d. Size and weight of members.
 - e. Location and size of cuts, copes, slots and holes.

- f. Type and location of shop and field connections.
 - g. Type, size and extent of welds. Indicate welds by welding symbols adopted by the American Welding Society.
 - h. Joint welding procedures and welding sequence.
 - i. Painting materials and procedures.
2. Welding
- a. Certification of welder's qualifications.
 - b. Welding procedure: Submit descriptive data to illustrate welding procedures to be performed.
 - c. Field welding equipment: Submit descriptive data for field welding equipment including type, voltage and amperage.
3. Erection procedure: Submit descriptive data to illustrate structural steel erection procedure, including sequence of erection and temporary staging and bracing at request of the A/E.
4. Proof of material compliance: Fabricator to maintain quality assurance records with mill test reports verifying compliance to material specification. Fabricator shall forward a copy of the records to A/E at the completion of the project.
- B. Submit structural properties for all field purchased material.
- C. The Independent Testing Agency shall submit reports on tests and inspections performed to the Owner, the A/E, and the Contractor.

1.4 QUALITY ASSURANCE

- A. Fabricator must be a firm regularly engaged in structural steel fabrication with a minimum of 5 years of experience in the fabrication of structural steel similar to the requirements of this project, or possess current AISC Quality Certification - Category I.
- B. Steel Erector's Qualifications: Steel shall be erected by an experienced erector who upon request of the A/E shall submit evidence of successful erection of steel under similar job conditions.
- C. Welding Qualifications: Welding procedures, welders, welding operations, and tackers shall be qualified in accordance with AWS D1.1.
1. Welders who have not performed welding for period of 3 or more months shall be requalified.
 2. Welders whose work fails to pass inspection shall be requalified before performing further welding.
 3. The Contractor shall pay costs of certifying qualifications.
- D. Testing
1. Independent Testing Agency shall inspect high strength bolted and welded connections and to perform test specified.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the site dry and store above ground on wood blocking allowing drainage of water from all parts. Handle steel with care to avoid bending, twisting, or other damage.
- B. Fasteners shall be protected from dirt and moisture at the job site. Only as many fasteners as are anticipated to be installed and tightened during a work shift shall be taken from protected storage. Fasteners shall not be cleaned of lubricant that is present in as-delivered condition.

PRODUCTS

1.6 MATERIALS

- A. Steel W Shapes: ASTM A992.
- B. Channels, Angles, Bars, Plates and Rods: ASTM A36.
- C. Steel Pipe; Black, Hot-dipped Galvanized, Zinc-coated Welded, and Seamless Steel Pipe: ASTM A53, Grade B.
- D. Structural Steel Tubing: ASTM A500, Grade B or Grade C.
- E. Bolts, Washers and Nuts.
 - 1. Load indicating bolting system uses "Tru-Tension Bolts" as manufactured by Nucor Fastener. Bolts conform to ASTM F3125 Grade 325.
 - 2. Nuts: ASTM A563, Grade DH, heavy hex nuts.
 - 3. Washers: ASTM F436.
- F. Headed Anchor Shear Studs.
 - 1. Headed anchor shear stud connectors shall conform to the requirements of AWS D1.1.
 - 2. Studs shall be made from cold drawn bar stock conforming to the requirements of ASTM A108, Grades C-1010 through C-1020.
 - 3. Studs shall have a minimum tensile strength of 55,000 psi and a minimum yield strength of 55,000 psi.
 - 4. Use Nelson studs H4L or S3L as manufactured by TRW Nelson Stud Welding Division; or approved equal.
- G. Anchor Bolts: ASTM A307 or ASTM A36.
- H. Threaded Rods: ASTM A36.
- I. Welding Electrodes: E70XX conforming to AWS D1.1.
- J. Primer: Fabricators standard shop primer.

1.7 FABRICATION

- A. General Requirements
 - 1. Fabricate structural steel in accordance with AISC and requirements of regulatory agencies.
 - 2. Fabricate and pre-assemble work in shop to greatest extent possible.
 - 3. Do shearing, flame cutting, and chipping carefully and accurately.
 - 4. Do not drift to match misaligned holes. Where enlarging is required, ream and use larger bolt. Misaligned holes will subject members to rejection.
 - 5. Coordinate as required for attachment of other work to structural steel.
 - 6. Unless specified otherwise, structural members shall be in accordance with dimensional tolerances of ASTM A6.
 - 7. Completed work shall be free of twists, bends and open joints.
 - 8. Horizontal structural members shall be fabricated without camber unless noted on the Drawings. No negative camber allowed.
- B. Fabrication Tolerances

1. Variation of 1/32 inch allowed in overall length of members with both ends finished for contact bearing.
 2. Variation of 1/16 inch allowed in overall connection length for members less than 30 feet in length and 1/8 inch for members over 30 feet in length with ends not finished for contact bearing.
 3. Variation of 1/1000 of the axial length between points of lateral support allowed for straightness of compression members.
- C. Connections
1. Shop connections welded, unless detailed or noted otherwise.
 2. Connections not shown to be in accordance with requirements of AISC.
- D. Bolted Connections
1. Punch or drill holes 1/16 inch larger than bolt size.
 2. Ream unfair holes, but only up to next larger bolt size. Where unfairness exceeds maximum, weld hole in base material solid and drill hole of proper size.
 3. As erection progresses, provide sufficient bolts to adequately resist dead load, lateral forces, and erection stresses.
- E. Welded Construction
1. Weld in accordance with AISC and ASW D1.1.
 2. Welds that will be exposed to view on the completed work shall be inspected and burrs, flux, welding oxide air spots, and discoloration removed. Grind, polish, or finish as specified or shown. Exterior welds shall be watertight.
 3. Butt-welds and groove welds.
 - a. Provide complete penetration welds.
 - b. If welded from one side, use backup plates.
 - c. If welded from both sides, back-scarf and clean root weld before depositing weld metal from second side.
 - d. Preheat for minimum 3 inches on each side of welds; maintain interpass temperatures in accordance with ASW D1.1.
 - e. If backup plates are used, remove prior to sonic testing.
 4. Grind exposed welds smooth.
 5. Prepare column bases in accordance with the provision of AWS and AISC.
- F. Shop Painting
1. Clean surfaces of steel before painting in accordance with SSPC SP-2, SP-3, or SP-7 and then remove oil and grease in accordance with SSPC SP-1.
 2. Paint inaccessible surfaces before assembly.
 3. Paint each item in shop with identification mark corresponding to identification on shop drawings.
 4. Apply shop prime paint to obtain a uniform dry film thickness of not less than 2 mil and suitable to receive field painting.

5. Omit prime paint on surfaces to receive shear connectors, top flanges at beams where metal deck is to be fastened by welding, faying surfaces of friction type bolted connections or where cementitious fireproofing is to be applied.

1.8 QUALITY ASSURANCE

- A. Fabricator to provide access for shop inspections by the Project Engineer as required. A minimum of 24 hours notification will be given prior to inspections.

EXECUTION

1.9 INSPECTION

- A. Contractor to verify that all anchor bolts have been installed properly. Unsatisfactory conditions shall be corrected before erection may begin.

1.10 FIELD FABRICATION

- A. Structural steel requiring field fabrication shall be done in accordance with AISC practices and subject to the approval of the A/E.

1.11 ERECTION TOLERANCES

- A. Columns
 1. Maximum per floor deviation of the column working line from a plumb line shall not exceed 1/500 (approximately 1/4 inch in 12 feet).
 2. In addition, maximum overall deviation of the column working line from the established column line shall not exceed 5/16 inch for columns up to 5 stories in height, and 1/16 inch per story for columns greater than 5 stories in height (that is 7/16 inch for 7 story columns).
- B. Horizontal Members
 1. The elevation of the working point of horizontal members shall not deviate more than plus 3/16 inch or minus 5/16 inch from the elevation specified on the Drawings.
- C. Perimeter Angle
 1. Perimeter angle shall be located within plus or minus 1/8 inch of their location specified on the Drawings.

1.12 ERECTION

- A. Comply with the AISC Specification and Code of Standard Practice, and with specified requirements.
 1. Maintain work in a safe and stable condition during erection.
 2. Provide as required, temporary supports, such as temporary guys, braces, falsework, cribbing or other elements required for the erection operation, with connections of sufficient strength to support imposed loads.
 3. Remove temporary supports, members, and connections when permanent members are in place and final connections are made.
- B. Set structural members to the lines and elevations indicated on the Drawings. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces which shall be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
- C. Splice members only where indicated on the Drawings.
- D. Normal erection operations include the correction of minor misfits by moderate amounts of reaming, chipping, welding or cutting, and the drawing of elements into line through the use of drift pins. Errors

which require major changes in member configuration or connections are to be reported to the Designer/ Builder for evaluation.

E. Cuts, Alterations and Holes

1. Do not enlarge unfair holes in members by burning or by the use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.
2. Do not use gas cutting torches in the field for correcting fabrication errors in primary structural framing. Cutting, with the approval of the A/E, will be permitted on secondary members that are not under stress.
3. Where gas cutting is permitted provide the following.
 - a. Make cuts smooth and regular in contour.
 - b. To determine effective width of the cut member, deduct an 1/8 inch from the least width at the cut edge.
 - c. Make radius or re-entrance of cut fillet as large as practical, but in no case less than 1 inch.
 - d. The erector will neither cut, drill or otherwise alter any work to accommodate other trades, unless such work is clearly specified on the Drawings or with approval from the A/E.

F. Welding

1. All welding for structural steel connections shall be in accordance with AWS D1.1.
2. Grind welds to a smooth finish where structure is architecturally exposed.

G. Field Painting

1. Immediately after erection clean and touch-up painting on field welds, bolted connections, unprimed exposed areas, and abraded areas of the shop paint or structural steel as required.
2. Use paint of the same material as used for shop painting.
3. Apply by brush or spray to provide a minimum film thickness of 3.0 mils wet.

H. High Strength Bolts

1. Tension control bolts
 - a. Installation of load indicating bolting systems are designed to be installed with various types of portable electric wrenches specifically intended for use with this style of structural fastener.
 - b. Prior to installation of bolts test three bolts in a calibration device capable of indicating bolt tension. The test assembly shall include flat hardened washers. The calibration test shall demonstrate that the device indicates a tension not less than five percent greater than that required by Table 4 of the Specifications for Structural Joints using ASTM F3125 Grade 325 or Grade 490 Bolts in the AISC Manual of Steel Construction.
 - c. Install hardened washers under turned element of all high strength bolts, and over short-slotted holes in outer ply.
 - d. Install bolts in all holes of the connection and bring bolts to a snug tight condition. Tighten all fasteners, following manufacturer's installation procedures, starting from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners prior to final twist-off the indicator element.

In some cases, proper tensioning of the bolts may require more than a single cycle of systematic tightening.

- e. If load indicating bolts shall not be installed using the proper installation wrench, due to clearances or obstructions, tighten the bolts in the following manner.
 - 1) Bolts in connections not subject to tension loads may be tightened to the snug tight condition, which may be attained by a few impacts of an impact wrench or the full effort of a person using an ordinary spud wrench.
 - 2) Bolts in connections subject to tension (such as open web girder end connections, column splices, etc.) shall be tightened by "turn-of-nut" method per AISC "Specification for Structural Joints using ASTM F3125 Grade 325 or Grade 490 Bolts" where all bolts in a connection are brought to snug tightness and then tightened an additional one-third turn or by using tension control bolts.
- f. Reuse of bolts
 - 1) ASTM F3125 Grade 325 bolts shall not be reused.
 - 2) Touching up or re-tightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered as reuse provided the snugging up continues from the initial position and does not require greater rotation including the tolerance, than that required by Table 5 of the Specifications for Structural Joints using ASTM F3125 Grade 325 or Grade 490 Bolts in the AISC Manual of Steel Construction.

1.13 TESTING

- A. The Independent Testing Agency shall provide the following.
 - 1. Visual inspection of welds shall be performed on all full penetration welds, all moment connection welds, and all welds on primary bracing (lateral wind bracing).
 - 2. Visually inspect all bolted connections. Splines of all twist-off bolts shall be twisted off. No gaps shall be present in the immediate vicinity of the bolts, although gaps may be present between layers of steel away from the holes. As a minimum, the end of a bolt shall be flush with the face of the nut. The maximum stickout must be verified with a sample bolt by running the nut up the threads but allowing one full turn at the end for retensioning.
 - 3. If defects or deficiencies are found, the Structural Engineer shall determine required remedies and any additional inspection requirements.

1.14 CLEANING

- A. After erection, thoroughly clean surfaces of foreign or deleterious matter such as dirt, mud, oil, or grease that would impair the bonding of fireproofing or concrete.

END OF SECTION 05 12 00

SECTION 05 40 00 COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Load-bearing wall framing.
 - 2. Interior non-load-bearing wall framing.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Cold-formed steel framing materials.
 - 2. Load-bearing wall framing.
 - 3. Interior non-load-bearing wall framing.
 - 4. Vertical deflection clips.
 - 5. Single deflection track.
 - 6. Double deflection track.
 - 7. Drift clips.
 - 8. Post-installed anchors.
 - 9. Power-actuated anchors.
- B. Shop Drawings:
 - 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
 - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product certificates.
- C. Product test reports.
- D. Research Reports:
 - 1. For post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- D. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Cold-formed metal framing products shall be provided by one of the following or approved equal:
1. Clark Dietrich
 2. Nucon Steel
 3. Marinoware

2.2 PERFORMANCE REQUIREMENTS

- A. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
1. Wall Studs: AISI S211.
 2. Headers: AISI S212.
 3. Lateral Design: AISI S213.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
1. Grade: As required by structural performance.
 2. Exterior or exposed use coating: G90 (Z275) or equivalent.
 3. Standard use coating: G60 (Z180) or equivalent.
- B. Steel Sheet for Vertical Deflection or Drift Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:
1. Grade: As required by structural performance.
 2. Exterior or exposed use coating: G90 (Z275) or equivalent.
 3. Standard use coating: G60 (Z180) or equivalent.

2.4 LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Minimum Flange Width: 1-5/8 inches.
 3. Section Properties: As required for structural performance.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and matching minimum base-metal thickness of steel studs.

- C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Minimum Flange Width: 1-5/8 inches.
 - 3. Section Properties: As required for structural performance.

2.5 INTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inches.
 - 2. Minimum Flange Width: 1-5/8 inches.
 - 3. Section Properties: As required for structural performance.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and matching minimum base-metal thickness of steel studs.
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure.
- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
- F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated.

2.7 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.
- B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.
- C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC193, ICC-ES AC58, or ICC-ES AC308 as appropriate for the substrate.
 - 1. Uses: Securing cold-formed steel framing to structure.
 - 2. Type: Torque-controlled expansion anchor. torque-controlled adhesive anchor, or adhesive anchor.

3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
 4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).
- D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

2.8 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A780/A780M, MIL-P-21035B, or SSPC-Paint 20.
- B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sill Sealer Gasket: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.
- C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sill sealer gasket at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.2 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
- D. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

- E. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- F. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- G. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- H. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.3 INSTALLATION OF LOAD-BEARING WALL FRAMING

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
 - 1. Anchor Spacing: To match stud spacing unless shown on Shop Drawings.
- B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch between the end of wall-framing member and the web of track.
 - 1. Fasten both flanges of studs to top and bottom tracks.
 - 2. Space studs as follows:
 - a. Stud Spacing: As indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.
- F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.
- G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
 - 1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.
 - 2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
 - 1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
- I. Install horizontal bridging in stud system, spaced vertically not less than 48 inches or as indicated on Shop Drawings. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches deep.
 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- J. Install steel sheet diagonal bracing straps to both stud flanges; terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
- K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.4 INSTALLATION OF INTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to bottom track unless otherwise indicated. Fasten top track as required for deflection criteria. Space studs as follows:
1. Stud Spacing: 16 inches unless specifically indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
1. Install single deep-leg deflection tracks and anchor to building structure.
 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 3. Connect vertical deflection clips to studs and anchor to building structure.
 4. Connect drift clips to cold-formed steel metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
1. Install solid blocking at centers indicated on Shop Drawings.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.6 REPAIRS

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 05 40 00

SECTION 05 73 00 DECORATIVE METAL RAILINGS

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, including description of materials, components, finishes, fabrication details, glass, anchors, and accessories.
- B. Shop Drawings: Indicate railing system elevations and sections, details of profile, dimensions, sizes, connection attachments, anchorage, size and type of fasteners, and accessories. Indicate anchor and joint locations, brazed connections, transitions, and terminations.
- C. Test Reports: Submit test reports from independent testing agency showing compliance with specified design and performance requirements.
- D. Designer's qualification statement.
- E. Manufacturer's qualification statement.

1.02 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.01 RAILING SYSTEMS

- A. General: Factory- or shop-fabricated to suit project conditions, for proper connection to building structure, and in largest sizes practical for delivery to site.
- B. Performance Requirements: Applying loads simultaneously not required; design and fabricate railings and anchorages to resist loads without failure, damage, or permanent set, including:
 - 1. Lateral Force: 75 lb minimum, when tested in accordance with ASTM E935.
 - 2. Distributed Load: 50 lbf/ft minimum, applied vertically and horizontally at top of handrail, when tested in accordance with ASTM E935.
 - 3. Concentrated Loads: 200 lb minimum, applied to handrail horizontally and vertically, in accordance with ASTM E935.
- C. Assembly: Use slip-on, nonweld mechanical fittings, flanges, escutcheons, and wall brackets to join lengths, seal open ends, and conceal exposed mounting bolts and nuts.
- D. Joints: Machined smooth with hairline seams; tightly fitted and secured.
- E. Field Connections: Provide sleeves to accommodate site assembly and installation.
- F. Metal Railing: Engineered, post-supported railing system with metal infill.
 - 1. Configuration: As indicated on Drawings.
 - 2. Decorative Flanges for Embedded Posts: Circular, collared cover plate without screw holes.
 - 3. Wall-Mounted Components: Support railing with 1-1/2-inch clearance from wall using the following:
 - 4. Handrail Brackets: Same metal as railing.
 - 5. Fasteners: Concealed.

- G. Glazed Post Railing System: Engineered, post-supported railing system with wood trim and glass infill panels.
 - 1. Configuration: Guardrail with separate handrail.
 - 2. Glass Mounts: Wood stops to match wood trim.

2.02 MATERIALS

- A. Steel Components:
 - 1. Sections, Shapes, Plate and Bar: ASTM A36/A36M.
 - 2. Tubing: ASTM A501/A501M structural tubing, round and shapes as indicated.
 - 3. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, galvanized in accordance with ASTM A153/A153M.
- B. Glass: Laminated safety glass; ASTM C1172.
 - 1. Plastic Interlayer: Minimum 0.060 inch thick.
 - 2. Impact Strength: Category II, tested in accordance with 16 CFR 1201.
 - 3. Thickness: 3/4 inch.
 - 4. Configuration: As indicated on drawings.
- C. Wood for Railings: Comply with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 7 - Stairwork & Rails, at manufacturer's premium grade.
 - 1. Species: Quartersawn Ash.

2.03 FABRICATION

- A. Joints in metal and wood: Make visible joints butt tight, flush, and hairline; use methods that avoid discoloration and damage of finish.
 - 1. Ease exposed edges to small uniform radius

2.04 FINISHES

- A. Wood Finishes:
 - 1. Comply with Section 09 93 00 Staining and Transparent Finishing.
- B. Steel Finishes:
 - 1. Coated Steel: Clean surface in accordance with SSPC-SP 1 before applying coating.
 - 2. Primer: Compatible with organic coating; shop-applied.
 - 3. Baked-Enamel Finish: Manufacturer's standard two-coat baked-enamel finish; topcoat minimum dry film thickness of 1 mil, 0.01 inch. Total minimum dry film thickness of 2 mils, 0.02 inch.
 - 4. Color: As indicated on drawings.

2.05 ACCESSORIES

- A. Welding Fittings: Factory- or shop-welded from matching pipe or tube; joints and seams ground smooth.
- B. Anchors and Fasteners: Provide anchors, fasteners, and other attachment devices required to attach to structure. Ensure attachment devices are of same material as components unless indicated otherwise.
 - 1. Posts: Provide adjustable flanged brackets.
 - 2. For anchorage to stud walls, provide backing plates for bolt anchors. See Section 09 21 16.

PART 3 – EXECUTION**3.01 EXAMINATION**

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.02 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 2. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.03 ATTACHING RAILINGS

- A. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.
- B. Attach handrails to walls with wall brackets. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- C. Secure wall brackets to building construction as follows:
 - 1. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.

3.04 INSTALLING GLASS PANELS

- A. Erect posts and other metal railing components, then set factory-cut glass panels. Do not cut, drill, or alter glass panels in field. Protect edges from damage.

3.05 CLEANING

- A. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.
- B. Clean wood rails by wiping with a damp cloth and then wiping dry.

3.06 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 73 00

SECTION 06 10 00 ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Framing with dimension lumber.
 2. Framing with engineered wood products.
 3. Rooftop equipment bases and support curbs.
 4. Wood blocking and nailers.
 5. Wood furring.
 6. Wood sleepers.
 7. Plywood backing panels.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.

1.3 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- B. Evaluation Reports: For the following, from ICC-ES:
1. Wood-preservative-treated wood.
 2. Fire-retardant-treated wood.
 3. Engineered wood products.
 4. Power-driven fasteners.
 5. Post-installed anchors.
 6. Metal framing anchors.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 3. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

- C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
 - 1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC2 for interior construction not in contact with ground, use Category UC3b for exterior construction not in contact with ground, and use Category UC4a for items in contact with ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 - 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 - 4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
 - 5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
 - 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

- E. Application: Treat items indicated on Structural and Architectural Drawings.

2.4 DIMENSION LUMBER FRAMING

- A. Non-Load-Bearing Interior Partitions: Construction, Stud, or No. 3 grade.
 - 1. Application: Interior partitions not indicated as load bearing.
 - 2. Species:
 - a. Spruce pine fir, SPF; or Southern pine; S.Pine.
 - b. Northern species; NLGA.
 - c. Eastern softwoods; NeLMA.
 - d. Western woods; WCLIB or WWPA.
- B. Load-Bearing Walls: See Drawings
- C. Exposed Framing: Hand-select material for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
 - 1. Species and Grade: As indicated above for load-bearing construction of same type.

2.5 ENGINEERED WOOD PRODUCTS

- A. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D5456 and manufactured with an exterior-type adhesive complying with ASTM D2559. See Structural Drawings for required material strengths.
- B. Rim Boards: Product designed to be used as a load-bearing member and to brace wood I-joists at bearing ends, complying with research or evaluation report for I-joists.
 - 1. Manufacturer: Provide products by same manufacturer as I-joists.
 - 2. Material: All-veneer product.
 - 3. Thickness: 1-1/8 inches or as shown on Drawings.
 - 4. Comply with APA PRR-401, rim board grade. Factory mark rim boards with APA-EWS trademark indicating thickness, grade, and compliance with APA-EWS standard.

2.6 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
 - 5. Furring.
 - 6. Grounds.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.
- C. Concealed Boards: 15 percent maximum moisture content and **any of** the following species and grades:
 - 1. Mixed southern pine or southern pine; No. 2 grade; SPIB.

2. Spruce pine fir; No 2 grade; SPF.

2.7 FASTENERS

- A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.
 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or of Type 304 stainless steel.
- B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

2.8 METAL FRAMING ANCHORS

- A. Allowable design loads, as published by manufacturer, shall meet or exceed those indicated of basis-of-design products. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.
- B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G60 coating designation.
 1. Use for interior locations unless otherwise indicated.
- C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
 1. Use for wood-preservative-treated lumber and where indicated.

2.9 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets: Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch nominal thickness, compressible to 1/32 inch; selected from manufacturer's standard widths to suit width of sill members indicated.
- B. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
- C. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

- G. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- H. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.

END OF SECTION 06 10 00

SECTION 06 16 00 SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wall sheathing.
 - 2. Roof sheathing.
 - 3. Parapet sheathing.
 - 4. Subflooring.
 - 5. Underlayment.
 - 6. Sheathing joint and penetration treatment.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.

1.3 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preserved-treated plywood.
 - 2. Fire-retardant-treated plywood.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WOOD PANEL PRODUCTS

- A. Emissions: Products shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, use Category UC3b for exterior construction not in contact with ground, and use Category UC4a for items in contact with ground.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing]

2.4 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-

response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

- B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
 - 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
 - 3. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to ASTM D6305. Span ratings after treatment shall be not less than span ratings specified.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat plywood indicated on Drawings.

2.5 WALL SHEATHING

- A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2, Exposure 1 sheathing.
- B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1 sheathing.
- C. Paper-Surfaced Gypsum Sheathing: ASTM C1396/C1396M, gypsum sheathing; with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges.
 - 1. Type and Thickness: Type X, 5/8 inch thick.
- D. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
 - 1. Type and Thickness: Type X, 5/8 inch thick.
- E. Cementitious Backer Units: ASTM C1325, Type A.
 - 1. Thickness: As indicated.
- F. Extruded-Polystyrene-Foam Sheathing: ASTM C578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with manufacturer.
 - 1. Thickness: As indicated.
 - 2. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.

2.6 ROOF SHEATHING

- A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2, Exterior sheathing.
- B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1 sheathing.

2.7 PARAPET SHEATHING

- A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2, Exterior sheathing.
- B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1 sheathing.

2.8 SUBFLOORING AND UNDERLAYMENT

- A. Plywood Combination Subfloor-Underlayment: DOC PS 1, Exposure 1, Underlayment single-floor panels.
- B. Oriented-Strand-Board Combination Subfloor-Underlayment: DOC PS 2, Exposure 1 single-floor panels.
- C. Plywood Subflooring: Either DOC PS 1 or DOC PS 2, Exposure 1 single-floor panels or sheathing.
- D. Oriented-Strand-Board Subflooring: DOC PS 2, Exposure 1.
- E. Underlayment: Provide underlayment in nominal thicknesses indicated or, if not indicated, not less than 1/4 inch over smooth subfloors and not less than 3/8 inch over board or uneven subfloors.
 - 1. Plywood Underlayment for Resilient Flooring: DOC PS 1, Exposure 1 Underlayment with fully sanded face.
 - 2. Plywood Underlayment for Ceramic Tile: DOC PS 1, Exterior, C-C Plugged, not less than 5/8-inch nominal thickness.
 - 3. Plywood Underlayment for Carpet: DOC PS 1, Exposure 1, Underlayment.
 - 4. Particleboard Underlayment: ANSI A208.1, Grade PBU.
 - 5. Hardboard Underlayment: ANSI A135.4, Class 4 (Service), Surface S1S; with back side sanded.

2.9 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For roof, parapet, and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

2.10 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Paper-Surfaced Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 "Joint Sealants."
- B. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
 - 1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.
- C. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

2.11 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with APA AFG-01 or ASTM D3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.
- D. Coordinate wall, parapet, and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
 - 1. Combination Subfloor-Underlayment:
 - a. Glue and nail to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.
 - 2. Subflooring:
 - a. Glue and nail to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.
 - 3. Wall and Roof Sheathing:
 - a. Nail to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.
 - 4. Underlayment:
 - a. Nail to subflooring.
 - b. Space panels 1/32 inch apart at edges and ends.
 - c. Fill and sand edge joints of underlayment receiving resilient flooring immediately before installing flooring.

3.3 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to wood framing with screws.
 - 2. Fasten gypsum sheathing to cold-formed metal framing with screws.
 - 3. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
 - 4. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Seal sheathing joints according to sheathing manufacturer's written instructions.
 - 1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
 - 2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.4 CEMENTITIOUS BACKER UNIT INSTALLATION

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.5 PARTICLEBOARD UNDERLAYMENT INSTALLATION

- A. Comply with CPA's recommendations for type of subfloor indicated. Fill and sand gouges, gaps, and chipped edges. Sand uneven joints flush.
 - 1. Fastening Method: Glue and nail underlayment to subflooring.

3.6 HARDBOARD UNDERLAYMENT INSTALLATION

- A. Comply with CPA's recommendations and hardboard manufacturer's written instructions for preparing and applying hardboard underlayment.
 - 1. Fastening Method: Nail underlayment to subflooring.

END OF SECTION 06 16 00

SECTION 06 20 00 FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Interior standing and running trim.
 - a. Wood base
 - b. Wood trim at pocket door
 - c. Wood trim at columns
 - d. Wood trim at kids entry portal 201.
 - e. Stair treads, risers and stringers.
 2. Custom service desk.
 3. Custom lockers at 119 and 311.
 4. Custom wood paneling at Fireplace Lounge 102.
 5. Custom wood framed windows at Stair 215.
 6. Custom shelving, benches and playhouse at Kids Library 201.
 7. Custom ceiling clouds at Kids Library 201.
 8. Custom bench at Hall 304.
 9. Upholstered cushions at custom benches.
 10. Art display rails.
 11. Solid-surface window sills.
- B. Related Sections include the following:
1. Section 06 10 00 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
 2. Section 06 41 00 "Architectural Wood Casework" for plastic laminate casework.
 3. Section 12 32 00 "Countertops" for Countertops.
 4. Section 08 32 10 "Custom Sliding Gates and Fixed Screens" for similar wood custom construction.

1.2 DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated including cabinet hardware and accessories and finishing materials and processes.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
1. Show details full size.
 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 3. Show locations and sizes of cutouts and holes for plumbing fixtures faucets soap dispensers and other items installed in architectural woodwork.
 4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
- C. Samples for Verification:

1. Lumber with or for transparent finish, not less than 5 inches wide by 24 inches long, for each species and cut, finished on 1 side and 1 edge.
2. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish.
3. Solid-surfacing / quartz materials, 6 inches square.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of product, signed by product manufacturer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products certified participant in AWI's Quality Certification Program.
- B. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers and wood doors with face veneers that are sequence matched with woodwork and transparent-finished wood doors that are required to be of same species as woodwork.
- C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
 1. **ALL ITEMS IN THIS SECTION TO MEET CUSTOM GRADE STANDARDS.**
- D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- C. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Species, Cut and Finish: As listed in the finish schedule.
- C. Wood Products: Comply with the following:
 - 1. Low-Emitting Materials: Composite wood products shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - 2. Hardboard: AHA A135.4.
 - 3. Medium-Density Fiberboard: ANSI A208.2, Grade MD made with binder containing no urea formaldehyde.
 - 4. Particleboard: ANSI A208.1, Grade M-2 made with binder containing no urea formaldehyde.
 - 5. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.
 - 6. Softwood Plywood: DOC PS 1 Medium Density Overlay.
- D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
 - 1. Colors and Patterns: As listed in the finish schedule.
- E. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
 - 1. Type: Standard type or Veneer type made from material complying with requirements for Standard type, as indicated.
 - 2. Colors and Patterns: As listed in the finish schedule.
- F. Upholstered bench seats:
 - 1. Molded Polyurethane Foam Padding: ASTM D 3770, combustion modified high resilience foam; complying with ASTM D 3453, for Dynamic Fatigue Performance Grade AD (heavy duty use) for seats and BD (normal duty use) for backs, and, for load bearing and general physical properties, of grade standard with manufacturer for kind of seat construction and fabric covering indicated.\
 - 2. Fabric: Custom fabric from the same dye lot, color and pattern as listed on the finish list.

2.2 ACCESSORIES

- A. Grommets for Cable Passage through Countertops:
 - 1. Doug Mockett & Company; BRV1, Satin Chrome Aluminum Brush Grommet
 - 2. Provide one for every 4 linear feet of countertop, locations TBD
- B. Coat Hooks
 - 1. Typical heavy duty double prong coat hook in satin chrome.
 - 2. Locations as shown on the drawings.
- C. Art Display Rail
 - 1. Manufacturer: Walker Display
 - 2. Model: Timeless Modern Molding.
 - 3. Aluminum molding, 8 ft. lengths, concealed mounting.
 - 4. Finish to be selected from manufacturer's standard paint colors.
 - 5. Provide matching end caps anywhere ends will be exposed.
 - 6. Provide (1) molding hook for every 2 linear feet of molding, in matching finish.

2.3 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- C. Adhesives, General: Adhesives shall not contain urea formaldehyde.
- D. Low-Emitting Materials: Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-scale Environmental Chambers."
- E. VOC Limits for Installation Adhesives: Installation adhesives shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Wood Glues: 30 g/L.
 - 2. Multipurpose Construction Adhesives: 70 g/L.
 - 3. Contact Adhesive: 250 g/L.
- F. Adhesive for Bonding Plastic Laminate: Un-pigmented contact cement.
 - 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.4 FABRICATION, GENERAL

- A. Wood Moisture Content: Comply with requirements of referenced quality standards for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- B. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch.
- C. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
 - 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- D. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of openings in countertops with a coat of varnish.
- E. Install glass to comply with applicable requirements in Section 088000 "Glass and Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

2.5 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

- A. Wood Species, Cut and Finish: See finish schedule.

- B. For trim items, do not use veneered construction. Do not glue for width.
- C. For rails, do not use veneered construction. Do not glue for width.
- D. Back-out or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

2.6 SOLID-SURFACING-MATERIAL COUNTERTOPS

- A. Grade: Premium.
- B. Solid-Surfacing-Material Thickness: 3/4 inch.
- C. Colors, Patterns, and Finishes: See finish key on drawings.
- D. Fabricate tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
- E. Fabricate tops with shop-applied edges of same material as countertop and of configuration indicated.

2.7 SHOP FINISHING

- A. Grade: Provide finishes of same grades as items to be finished.
- B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- C. Finishing Materials: Products shall comply with the testing and product requirements of the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
 - 1. Back-priming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require back-priming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.
- E. Finish:
 - 1. AWI Finish System: Conversion varnish.
 - 2. Color: Clear.
 - 3. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

2.8 UPHOLSTERED SEAT FABRICATION

- 1. General: Fabricate cushions using foam padding and fabric covering materials that are carefully selected to be free of defects or irregularities.
- 2. Cushions: Fabricate as follows:
 - a. Wrap all foam pads with bonded Dacron batting.
 - b. Upholster all surfaces with replaceable slip-on fabric covers, free of creases, stretch lines, or wrinkles. For each upholstered component, install pile and pattern run in a consistent direction unless otherwise indicated.
 - c. Fabricate with boxed edges and double stitched seams.
 - d. Cushions longer than standard length of foam padding shall consist of pieces glued using bulk non-flammable formulation foam adhesive to form one continuous cushion.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 36 inches long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
 - 1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base if finished.
 - 2. Install wall railings on indicated metal brackets securely fastened to wall framing.
 - 3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.
- G. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.
 - 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips.
- H. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 3. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.

4. Calk space between backsplash and wall with sealant specified in Section 079000 "Joint Sealants."
- I. Other items:
 1. Install at locations shown on drawings, level and plumb.
 2. Verify solid backing, if existing wall, use drywall anchor type screws if required.
 3. Coordinate with installation of adjacent items including fabric wrapped panels.
- J. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.3 ADJUSTING AND CLEANING

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

END OF SECTION 06 20 00

SECTION 06 16 00 SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wall sheathing.
 - 2. Roof sheathing.
 - 3. Parapet sheathing.
 - 4. Subflooring.
 - 5. Underlayment.
 - 6. Sheathing joint and penetration treatment.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.

1.3 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preserved-treated plywood.
 - 2. Fire-retardant-treated plywood.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WOOD PANEL PRODUCTS

- A. Emissions: Products shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, use Category UC3b for exterior construction not in contact with ground, and use Category UC4a for items in contact with ground.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing]

2.4 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-

- B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
 - 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
 - 3. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to ASTM D6305. Span ratings after treatment shall be not less than span ratings specified.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat plywood indicated on Drawings.

2.5 WALL SHEATHING

- A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2, Exposure 1 sheathing.
- B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1 sheathing.
- C. Paper-Surfaced Gypsum Sheathing: ASTM C1396/C1396M, gypsum sheathing; with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges.
 - 1. Type and Thickness: Type X, 5/8 inch thick.
- D. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
 - 1. Type and Thickness: Type X, 5/8 inch thick.
- E. Cementitious Backer Units: ASTM C1325, Type A.
 - 1. Thickness: As indicated.
- F. Extruded-Polystyrene-Foam Sheathing: ASTM C578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with manufacturer.
 - 1. Thickness: As indicated.
 - 2. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.

2.6 ROOF SHEATHING

- A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2, Exterior sheathing.
- B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1 sheathing.

2.7 PARAPET SHEATHING

- A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2, Exterior sheathing.
- B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1 sheathing.

2.8 SUBFLOORING AND UNDERLAYMENT

- A. Plywood Combination Subfloor-Underlayment: DOC PS 1, Exposure 1, Underlayment single-floor panels.

- B. Oriented-Strand-Board Combination Subfloor-Underlayment: DOC PS 2, Exposure 1 single-floor panels.
- C. Plywood Subflooring: Either DOC PS 1 or DOC PS 2, Exposure 1 single-floor panels or sheathing.
- D. Oriented-Strand-Board Subflooring: DOC PS 2, Exposure 1.
- E. Underlayment: Provide underlayment in nominal thicknesses indicated or, if not indicated, not less than 1/4 inch over smooth subfloors and not less than 3/8 inch over board or uneven subfloors.
 - 1. Plywood Underlayment for Resilient Flooring: DOC PS 1, Exposure 1 Underlayment with fully sanded face.
 - 2. Plywood Underlayment for Ceramic Tile: DOC PS 1, Exterior, C-C Plugged, not less than 5/8-inch nominal thickness.
 - 3. Plywood Underlayment for Carpet: DOC PS 1, Exposure 1, Underlayment.
 - 4. Particleboard Underlayment: ANSI A208.1, Grade PBU.
 - 5. Hardboard Underlayment: ANSI A135.4, Class 4 (Service), Surface S1S; with back side sanded.

2.9 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For roof, parapet, and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

2.10 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Paper-Surfaced Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 "Joint Sealants."
- B. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
 - 1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.
- C. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

2.11 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with APA AFG-01 or ASTM D3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.
- D. Coordinate wall, parapet, and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
 - 1. Combination Subfloor-Underlayment:
 - a. Glue and nail to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.
 - 2. Subflooring:
 - a. Glue and nail to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.
 - 3. Wall and Roof Sheathing:
 - a. Nail to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.
 - 4. Underlayment:
 - a. Nail to subflooring.
 - b. Space panels 1/32 inch apart at edges and ends.
 - c. Fill and sand edge joints of underlayment receiving resilient flooring immediately before installing flooring.

3.3 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to wood framing with screws.
 - 2. Fasten gypsum sheathing to cold-formed metal framing with screws.
 - 3. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.

4. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Seal sheathing joints according to sheathing manufacturer's written instructions.
1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
 2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.4 CEMENTITIOUS BACKER UNIT INSTALLATION

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.5 PARTICLEBOARD UNDERLAYMENT INSTALLATION

- A. Comply with CPA's recommendations for type of subfloor indicated. Fill and sand gouges, gaps, and chipped edges. Sand uneven joints flush.
1. Fastening Method: Glue and nail underlayment to subflooring.

3.6 HARDBOARD UNDERLAYMENT INSTALLATION

- A. Comply with CPA's recommendations and hardboard manufacturer's written instructions for preparing and applying hardboard underlayment.
1. Fastening Method: Nail underlayment to subflooring.

END OF SECTION 06 16 00

SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SUBMITTALS

- A Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
- B Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet, countertop, and shelf unit substrate and finish.
- C Samples: Submit actual sample items of proposed pulls, hinges, shelf standards, and locksets, demonstrating hardware design, quality, and finish.

PART 2 PRODUCTS

2.01 CABINETS

- A Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B Cabinets:
 - 1. Finish - Exposed Exterior Surfaces: Decorative laminate.
 - 2. Finish - Exposed Interior Surfaces: Decorative laminate.
 - 3. Finish - Semi-Exposed Surfaces: Decorative laminate
 - 4. Door and Drawer Front Edge Profiles: Square edge with hardwood edge bands to match decorative laminate..
 - 5. Grained Face Layout for Cabinet and Door Fronts: Flush panel.
 - a. Custom Grade: Doors, drawer fronts and false fronts wood grain to run and match vertically within each cabinet unit.
 - 6. Adjustable Shelf Loading: 40 psf.
 - a. Deflection: L/144.
 - 7. Cabinet Style: Flush overlay.
 - 8. Drawer Construction Technique: Dovetail joints.

2.02 WOOD-BASED COMPONENTS

- A Wood fabricated from old growth timber is not permitted.
- B Hardwood Edgebanding: Use solid hardwood edgebanding matching species, color, grain, and grade for exposed portions of cabinetry.

2.03 PANEL CORE MATERIALS

- A Particleboard: Composite panel composed of cellulosic particles, additives, and bonding system; comply with ANSI A208.1.
- B Medium Density Fiberboard (MDF): Composite panel composed of cellulosic fibers, additives, and bonding system; cured under heat and pressure; comply with ANSI A208.2.

2.04 HARDWOOD PLYWOOD PANELS

- A Hardwood Plywood: Plywood manufactured for nonstructural decorative applications; consisting of faces and backs applied to a variety of core types; comply with HPVA HP-1.

2.05 LAMINATE MATERIALS

- A High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.

B Provide specific types as follows:

1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, colors as indicated, finish as indicated.
2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, through color, _____ color, finish as indicated.
3. Cabinet Liner: CLS, 0.020 inch nominal thickness, color as selected, finish as selected.
4. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.06 COUNTERTOPS

- A Countertops: See Section 12 36 00.

2.07 ACCESSORIES

- A Grommets: Standard plastic or painted metal grommets for cut-outs, in color to match adjacent surface

2.08 HARDWARE

- A Drawer and Door Pulls: at Kitchen.

1. Omnia Industries; 9028/102.5; Ultima Collection; 4" center handle in antique brass lacquered

- B Drawer and Door Pulls: at cabinetry other than Kitchen

1. Hafele; Tab Handle, 106.04.061; 96 mm CTC; Oslo Collection; Dark Bronze

- C Keyed Cabinet Locks: Pushbutton cylinder, steel with satin finish.

- D Drawer Slides:

1. Type: Full extension.
2. Static Load Capacity: Commercial grade.
3. Mounting: Side mounted.

- E Soft-Close, Door and Drawer Adjustable Dampers:

2.09 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.

- E Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.

- B Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

- C Use concealed joint fasteners to align and secure adjoining cabinet units.

END OF SECTION 06 41 00

SECTION 071416 COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Polyurethane waterproofing.
 - 2. Protection course.
 - 3. Molded-sheet drainage panels.
- B. Related Section: 04 01 40.62 Brick Masonry and Repointing

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review waterproofing requirements including, but not limited to, the following:
 - a. Surface preparation specified in other Sections.
 - b. Minimum curing period.
 - c. Forecasted weather conditions.
 - d. Special details and sheet flashings.
 - e. Repairs.
 - f. Field quality control.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
 - 2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.
- B. Shop Drawings:
 - 1. Indicate locations and extent of waterproofing.
 - 2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
 - 3. Paver pedestal assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.
 - 1. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.

2. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.
 - B. Maintain adequate ventilation during application and curing of waterproofing materials.
- 1.7 WARRANTY
- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain waterproofing materials, protection course, and molded-sheet drainage panels from single source and from single manufacturer.

2.2 POLYURETHANE WATERPROOFING

- A. Single-Component, Modified Polyurethane Waterproofing: ASTM C836/C836M and coal-tar free.

2.3 COLD-APPLIED RUBBERIZED ASPHALT WATERPROOFING

- A. Single-Component, Rubberized Asphalt Waterproofing: Water-based, polymer-modified rubberized asphalt complying with ASTM C836/C836M, with the following properties measured in accordance with standard test methods referenced:
 1. Elongation at Break: 360 percent minimum; ASTM D412.
 2. Water Vapor Permeance: 0.03 perm, maximum, ASTM E96/E96M.
 3. Hydrostatic-Head Resistance: 100 psi average; ASTM D5385.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.
 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Manufacturer's standard primer, sealer, or surface conditioner; factory-formulated.
- C. Sheet Flashing: 50-mil- (1.3-mm-) minimum, nonstaining, uncured sheet neoprene.
 1. Adhesive: Manufacturer's recommended contact adhesive.
- D. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.
- E. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing; ASTM C920, Type M, Class 25 or greater; Grade NS for sloping and vertical applications and as recommended by manufacturer for substrate and joint conditions.

2.5 PROTECTION COURSE

- A. Protection Course, Semirigid Sheets of Fiberglass or Mineral-Reinforced Asphaltic Core: ASTM D6506, pressure laminated between two asphalt-saturated fibrous liners and as follows:
 - a. 1/8 inch (3 mm), nominal, for vertical applications.
2. Adhesive: Rubber-based solvent type recommended in writing by waterproofing manufacturer.

2.6 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21 mm) sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of 9 to 21 gpm per ft.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean, prepare, and treat substrates in accordance with manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces including exposed masonry wall above, not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

- A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C1471/C1471M.
- B. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

3.4 JOINT AND CRACK TREATMENT

- 1. Extend sheet flashings for 4 inches (100 mm) onto perpendicular surfaces and items penetrating substrate.

3.5 INSTALLATION OF WATERPROOFING

- A. Apply waterproofing in accordance with manufacturer's written instructions and to recommendations in ASTM C1471/C1471M.
- B. Start installing waterproofing in presence of manufacturer's technical representative.
- C. Apply primer over prepared substrate unless otherwise instructed in writing by waterproofing manufacturer.
- D. Unreinforced Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.
 - 1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of **120 mils (3 mm)**.
 - 2. Apply waterproofing to prepared wall terminations and vertical surfaces.
 - 3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft.
- E. Cure waterproofing, taking care to prevent contamination and damage during application and curing.
- F. Install protection course with butted joints over waterproofing before starting subsequent construction operations.
 - 1. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.

2. **Molded-sheet drainage panels** may be used in place of a separate protection course for vertical applications when approved in writing by waterproofing manufacturer.

3.6 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, in accordance with manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 1. For vertical applications, install protection course before installing drainage panels.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections:
 1. Testing agency to verify thickness of waterproofing during application for each 600 sq. ft. (56 sq. m) of installed waterproofing or part thereof.
- B. Waterproofing will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.8 PROTECTION

- A. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

END OF SECTION 07 14 16

SECTION 07 54 00 THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Provide data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners.
- B Shop Drawings: Submit drawings that indicate joint or termination detail conditions, conditions of interface with other materials, and paver layout.
- C 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 written verification that installation complies with warranty conditions for waterproof membrane.

1.02 WARRANTY

- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B Material Warranty: Provide membrane manufacturer's warranty agreeing to replace material that shows manufacturing defects within five years after installation.

PART 2 PRODUCTS

2.01 ROOFING - UNBALLASTED APPLICATIONS

- A Thermoplastic Membrane Roofing: One ply membrane, fully adhered, over insulation.
- B Acceptable Insulation Types - Tapered Application: Intended to match existing once exposed. .
 - 1. Tapered polyisocyanurate, perlite, or cellular glass board covered with uniform thickness polyisocyanurate, glass fiber, or composite board.
- C Primer, Roof Coating: Water-based primer with high-tack finish that promotes adhesion for elastomeric roof coatings.

2.02 MEMBRANE ROOFING AND ASSOCIATED MATERIALS

- A Membrane Roofing Materials:
 - 1. TPO: Thermoplastic polyolefin (TPO) complying with ASTM D6878/D6878M, sheet contains reinforcing fabrics or scrim.
 - a. Thickness: 45 mil, 0.045 inch, minimum.
 - 2. Sheet Width: As needed for patching.
 - 3. Color: _____.
- B Seaming Materials: As recommended by membrane manufacturer.
- C Vapor Retarder: Material approved by roof manufacturer complying with requirements of fire rating classification; compatible with roofing and insulation materials.
- D Flexible Flashing Material: Same material as membrane.

2.03 DECK SHEATHING

- A Deck Sheathing: Fiber-mat reinforced cement roofing boards, ASTM C1325, fire-resistant type, mold-resistant, 5/8 inch thick.

2.04 COVER BOARDS

- A Cover Boards: Glass-mat faced gypsum panels complying with ASTM C1177/C1177M.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A Perform work in accordance with manufacturer's instructions, NRCA (RM), and NRCA (WM) applicable requirements.
- B Do not apply roofing membrane during cold or wet weather conditions.
- C Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.02 INSTALLATION - VAPOR RETARDER AND INSULATION, UNDER MEMBRANE

- A Install vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
- B Attachment of Insulation:
 - 1. Mechanically fasten first layer of insulation to deck in accordance with roofing manufacturer's instructions and FM DS 1-28 Factory Mutual requirements.
 - 2. Embed second layer of insulation into full bed of adhesive in accordance with roofing and insulation manufacturers' instructions.
- C Cover Boards: Mechanically fasten cover boards in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.
- D Lay subsequent layers of insulation with joints staggered minimum 6 inches from joints of preceding layer.
- E Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.

3.03 INSTALLATION - MEMBRANE

- A Fully Adhered Application: Apply adhesive to substrate at rate as recommended by Manufacturer.. 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.
- B At intersections with vertical surfaces:
 - 1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
 - 2. Fully adhere flexible flashing over membrane and up to nailing strips.

END OF SECTION 07 54 00

SECTION 07 72 00 ROOF ACCESSORIES

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Manufacturer's data sheets on each product to be used.

1.02 WARRANTY

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

PART 2 PRODUCTS

2.01 ROOF HATCHES AND VENTS

- A Roof Hatches and Smoke Vents: Factory-assembled aluminum frame and cover, complete with operating and release hardware.
- B Flat Roof Access Hatch: Factory-assembled roof hatch with PVC frame and flat cover and folding metal access ladder, complete with operating and release hardware.
 - 1. Mounting Substrate: Provide frames and curbs suitable for mounting on flat roof deck sheathing with insulation.
 - 2. Mounting: Provide frames and curbs suitable for mounting conditions as indicated on drawings.
 - 3. Thermally Broken Hatches: Provide insulation within hatch frame and cover.
 - 4. Coordinate with placement Ships Ladder below.
- 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 inside hollow 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.
- E Safety Railing System: Roof hatch safety rail system mounted directly to curb without penetration of roofing system.
- F Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.
 - 1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf load.
 - 2. Hinges: Heavy duty pintle type.
 - 3. Hold open arm with vinyl-coated handle for manual release.
 - 4. Latch: Upon closing, engage latch automatically and reset manual release.
 - 5. Locking: Padlock hasp on interior.

PART 3 EXECUTION

3.01 INSTALLATION

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

END OF SECTION 07 72 00

SECTION 07 84 00 FIRESTOPPING

PART 1 GENERAL

1.01 SUBMITTALS

- A Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.

1.02 QUALITY ASSURANCE

- A Fire Testing: Provide firestopping assemblies or designs that provide the scheduled fire ratings when tested in accordance with methods indicated.

1.03 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 FIRESTOPPING SYSTEMS

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

PART 3 EXECUTION

3.01 INSTALLATION

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

END OF SECTION 07 84 00

SECTION 07 92 00 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. Silicone joint sealants.
 - 2. Latex joint sealants.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer 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.

1.7 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

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

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Single-Component, Non-sag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include:
 - a. Dow Corning Corporation.
 - b. GE Advanced Materials.
 - c. Pecora Corporation.
 - d. Sika Corporation, Construction Products Division.
 - e. Tremco Incorporated.

2.3 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include:
 - a. BASF Building Systems.
 - b. Pecora Corporation.
 - c. Tremco Incorporated.

2.4 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

3.4 CLEANING

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

3.5 PROTECTION

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

3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces.
 - 1. Joint Locations:
 - a. Perimeter joints of exterior openings where indicated.

- b. Tile control and expansion joints.
 - c. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
 - 2. Joint Sealant: Latex.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal non-traffic surfaces.
 - 1. Joint Location:
 - a. Acoustical joints where indicated.
 - 2. Joint Sealant: Acoustical.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 92 00

SECTION 08 11 13 HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
- B Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- C Samples: Submit three samples of metal, 2 by 2 inches in size, showing factory finishes, colors, and surface texture.

1.02 DELIVERY, STORAGE, AND HANDLING

- A Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A Requirements for Hollow Metal Doors and Frames:
 - 1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
 - 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
 - 4. Door Edge Profile: Manufacturers standard for application indicated.
 - 5. Typical Door Face Sheets: Flush.
 - 6. 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.
 - 7. Zinc Coating for Typical Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvanized) 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 NAAMM HMMA Custom Guidelines: Provide at least A25/ZF75 (galvanized) for interior applications, and at least A60/ZF180 (galvanized) or G60/Z180 (galvanized) 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.

2.02 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 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
 - 2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
 - 3. Door Thickness: 1-3/4 inches, nominal.
 - 4. Weatherstripping: Refer to Section 08 71 00.
 - 5. Door Finish: Factory finished.
- C Interior Doors, Non-Fire-Rated:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
 - 2. Door Thickness: 1-3/4 inches, nominal.
- D Fire-Rated Doors:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
 - 2. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
 - 3. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - a. Attach fire rating label to each fire rated unit.
 - 4. Door Thickness: 1-3/4 inches, nominal.

2.03 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 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: 18 gauge, 0.042 inch, minimum.
 - 3. Weatherstripping: Integral, recessed into frame edge.
- D Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
 - 1. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.

- E Door Frames, Fire-Rated: Full profile/continuously welded type.
 - 1. Fire Rating: Same as door, labeled.
 - 2. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
 - 3. Frame Finish: Factory finished.
- F Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- G Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.
- H Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.
- I Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

2.04 FINISHES

- A Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.
- B Factory Finish: Complying with ANSI/SDI A250.3, baked enamel.

2.05 ACCESSORIES

- A Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door and two on head of pairs without center mullions.
- B Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B Install fire rated units in accordance with NFPA 80.
- C Coordinate frame anchor placement with wall construction.

END OF SECTION 08 11 13

SECTION 08 14 16 FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- B 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.
- C Samples: Submit three samples of door veneer, 8 by 11 inches in size illustrating wood grain, stain color, and sheen.

1.02 QUALITY ASSURANCE

1.03 WARRANTY

- A 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

2.01 DOORS AND PANELS

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

2.02 DOOR AND PANEL CORES

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

2.03 DOOR FACINGS

- A Veneer Facing for Transparent Finish: Ash, veneer grade in accordance with quality standard indicated, quarter cut, with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.
 - 1. Vertical Edges: Any option allowed by quality standard for grade.
 - 2. "Pair Match" each pair of doors; "Set Match" pairs of doors within 10 feet of each other when doors are closed.
- B Facing Adhesive: Type I - waterproof.

2.04 DOOR CONSTRUCTION

- A Fabricate doors in accordance with door quality standard specified.
- B Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- C Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.

2.05 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 - 5, Varnish, Conversion.
 - b. Stain: Match Architect's sample.
 - c. Sheen: Semigloss.

2.06 ACCESSORIES

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

PART 3 EXECUTION

3.01 INSTALLATION

- A Install doors in accordance with manufacturer's instructions and specified quality standard.
 - 1. Install fire-rated doors in accordance with NFPA 80 requirements.
- B Coordinate installation of doors with installation of frames and hardware.

END OF SECTION 08 14 16

SECTION 08 32 10 CUSTOM SLIDING GATES and FIXED SCREENS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes wood and steel custom wood gates with hardware for interior locations and coordinating fixed screens.
- B. Related Sections:
 - 1. Section 06 10 13 – Rough Carpentry - Architectural; for blocking support behind panels and hardware.
 - 2. Section 06 20 00 – Finish Carpentry; for quality of work, finishing requirements

1.2 ACTION SUBMITTALS

- A. Shop Drawings: For custom fabricated gate illustrating overall design and hardware attachments.
- B. Samples: Final finish sample for approval.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Metal Surfaces, General:
 - 1. Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Wood Products:
 - 1. Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
ALL ITEMS IN THIS SECTION TO MEET CUSTOM GRADE STANDARDS.
 - 2. Wood Species, Cut and Finish: As listed in the finish schedule.

2.2 CUSTOM SLIDING GATE

- A. Gate:
 - 1. Frame is fabricated from steel extrusions complying with ASTM A 36/A 36M.
 - 2. Wood lattice to be fabricated from wood complying with Section 06 20 00.
 - 3. Hardware:
 - a. TRACK & TRUCKS:
 - 1) Crown Hardware #4-1P:
 - 2) Complete track/truck/stops assembly (400 lb.)
 - 3) Guides: Jamb Mounted Door Guides
 - b. FLUSH BOLT: Ives, SB1640-BL US10B (one per gate panel)
 - c. Coordinate mounting and installation.
 - 4. Fabricate custom gate according to the design and details provided.
 - 5. Shop applied finishes for metal components:
 - a. Final finish to be as indicated on Drawings.
 - b. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

- c. Intermediate and top coats: Latex interior institutional low odor/VOC (Gloss Level 5) MPI # 147.
- d. Field touch required prior to Substantial Completion.

2.3 CUSTOM FIXED SCREENS

- A. Fixed Screens:
 - 1. Match Sliding Gates above without sliding hardware.
 - 2. Provide continuous hinge and roller catch on wood screen to access Translucent panel for cleaning purposes.

2.4 FABRICATION, METAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces. Install hardware in shop to the extent possible, install hardware for vertically plumb hanging condition.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
- C. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended.
- D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.

2.5 FABRICATION, WOOD

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces. Install hardware in shop to the extent possible, install hardware for vertically plumb hanging condition.
- B. Wood Moisture Content: Comply with requirements of referenced quality standards for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Fabricate woodwork to dimensions, profiles, and details indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing doors, hardware, accessories, and other components.
- B. Drill holes in floor at locations approved by architect for three positions: Open, partially open (aligned with column) and closed. Install strikes for neat, clean appearance.
- C. Adjust gate to be level and plumb. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.

END OF SECTION 08 32 10

SECTION 08 52 00 WOOD WINDOWS

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Show component dimensions, anchorage and fasteners, glass, and internal drainage details.
- B Shop Drawings: Indicate opening dimensions, framed opening tolerances, affected related work, and installation requirements.
- C Samples: Two samples 6 by 6 inch in size, or manufacturer's standard sample, illustrating window frame section.
- D Operating Hardware: Two samples of each type of operating hardware.

1.02 WARRANTY

- A Manufacturer Warranty: Provide 10-year manufacturer warranty for insulated glass units against seal failure, interpane dusting or misting, and replacement of same. Complete forms in Owner's name and register with manufacturer.
- B Manufacturer Warranty: Provide 1-year manufacturer warranty against defects listed. Complete forms in Owner's name and register with manufacturer or warrantor.
 - 1. Degradation of factory-applied interior finish.
 - 2. Degradation of factory-applied exterior finish.

PART 2 PRODUCTS

2.01 WOOD WINDOWS

- A Wood Windows: Wood frame and sash, factory fabricated, finished and assembled.
 - 1. Manufacturer: H Window Company, LLC;
 - a. 401 17th Avenue West, Ashland, WI 54806;
 - b. (800) 843-4929;
 - c. www.HWindow.com
 - 2. Exterior Finish: Kynar DVDF, painted..
 - 3. Interior Finish: Factory Finished, painted.
 - 4. Color: Interior color to be Black, exterior color to be selected..
 - 5. Configuration: As indicated on drawings.
 - 6. Window Product Types: AP - Awning, hopper, projected window and FW - Fixed window, in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
 - 7. Factory glazed; dry glazing method.
 - 8. Interior Wood Species: Clear pine, preservative treated using treatment type suitable for required finish.
 - 9. Exterior Metal to be Manufacturer's standard extruded aluminum profiles.
 - 10. Clearances and Shim Spacing: Minimum required for installation and dynamic movement of perimeter seal.
 - 11. Fasteners: Concealed from view.

2.02 COMPONENTS

- A Glazing: Double glazed, clear, Low-E coated, argon filled, with glass thicknesses as recommended by manufacturer for specified wind conditions.
- B Tempered where required by code and where indicated on Drawings.
- C Frames: Manufacturers standard frame profile; flush solid wood glass stops of screw fastened type, sloped for positive drainage.
- D Sills: Extruded aluminum; sloped for positive drainage; fits under sash and projects at least 1/2 inch beyond exterior face of wall; single piece full width of opening.
- E Muntins/Grilles: Grilles permanently installed between panes of insulating glass.
 - 1. Pattern: Standard 1" SDL Grilles, Factory finished to match frames..
 - 2. Bar Width: 3/4 inch.
 - 3. Color: Match interior and exterior of frame.
- F Insect Screens: Extruded aluminum frame with mitered and reinforced corners; screen mesh taut and secure to frame; secured to window with adjustable supports allowing screen removal without use of tools.
 - 1. Supports: Spring-loaded steel pins; four per screen unit.
 - 2. Screen Mesh: Vinyl-coated fiberglass, window manufacturer's standard mesh.
 - 3. Frame Finish: Baked enamel, color to match window interior color.
- G Operable Sash Weatherstripping: Wool pile; permanently resilient, profiled to effect weather seal.
- H Wood for Casings and Trim: Clear pine, clear preservative treated, of type suitable for required finish.
 - 1. Scarf joints permitted in transparent finished exposed surfaces only if color and grain texture match.

2.03 HARDWARE

- A Operator for operable hopper units: Push Bar Operator fitted to projecting sash arms with limit stops; bronze finish.
- B Window Opening Control Devices (WOCD): Provide operable window sash hardware that limits openings to only allow passage of 4 inch diameter rigid sphere or less, and are easily releasable to fully open without use of keys, tools, or special knowledge.

2.04 ALUMINUM FINISHES

- A Superior Performing Organic Coatings: AAMA 2605, multiple coat, thermally cured polyvinylidene fluoride system.

PART 3 EXECUTION**3.01 INSTALLATION**

- A Install windows in accordance with manufacturer's instructions.
- B Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.
- C Install sills, stools, aprons, and jamb extensions.

3.02 ADJUSTING

- A Adjust hardware for smooth operation and secure weathertight closure.

END OF SECTION 08 52 00

SECTION 08 71 00 DOOR HARDWARE

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

- A Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- B Keying Requirements Meeting:
 - 1. Schedule meeting at project site prior to Contractor occupancy.
 - 2. Attendance Required:
 - a. Contractor.
 - b. Owner.
 - c. Architect.
 - d. Installer's Architectural Hardware Consultant (AHC).
 - e. Hardware Installer.
 - 3. Agenda:
 - a. Establish keying requirements.
 - b. Verify locksets and locking hardware are functionally correct for project requirements.
 - c. Verify that keying and programming complies with project requirements.
 - d. Establish keying submittal schedule and update requirements.
 - 4. Incorporate "Keying Requirements Meeting" decisions into keying submittal upon review of door hardware keying system including, but not limited to, the following:
 - a. Access control requirements.
 - b. Key control system requirements.
 - c. Schematic diagram of preliminary key system.
 - d. Flow of traffic and extent of security required.

1.02 SUBMITTALS

- A Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- B Shop Drawings - Door Hardware Schedule: Submit detailed listing that includes each item of hardware to be installed on each door. Use door numbering scheme as included in Contract Documents.
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
 - 2. Provide complete description for each door listed.
 - 3. Provide manufacturer name, product names, and catalog numbers; include functions, types, styles, sizes and finishes of each item.
- C Keying Schedule:
 - 1. Submit three (3) copies of Keying Schedule in compliance with requirements established during Keying Requirements Meeting unless otherwise indicated.

1.03 WARRANTY

- A Manufacturer's Warranty: Provide warranty against defects in material and workmanship for period indicated. Complete forms in Owner's name and register with manufacturer.
 - 1. Closers: Five years, minimum.
 - 2. Locksets and Cylinders: Three years, minimum.

3. Other Hardware: Two years, minimum.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B Provide door hardware products that comply with the following requirements:
 1. Applicable provisions of federal, state, and local codes.
 2. Listed and certified compliant with specified standards by BHMA (CPD).
 3. Auxiliary Hardware: BHMA A156.16.
 4. Hardware Preparation for Steel Doors and Steel Frames: BHMA A156.115.
 5. Hardware Preparation for Wood Doors with Wood or Steel Frames: BHMA A156.115W.
 6. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.

2.02 HINGES

- A Hinges: Comply with BHMA A156.1, Grade 1.
 1. Butt Hinges: Comply with BHMA A156.1 and BHMA A156.7 for templated hinges.
 - a. Finish: Oil Rubbed Bronze.
 2. Provide hinges on every scheduled swinging door.
 3. Provide five-knuckle full mortise butt hinges unless otherwise indicated.
 4. Provide ball-bearing hinges at each door with closer.
 5. Provide non-removable pins on exterior outswinging doors.
 6. Provide following quantity of butt hinges for each door:
 - a. Doors up to 60 inches High: Two hinges.
 - b. Doors From 60 inches High up to 90 inches High: Three hinges.
 - c. Doors 90 inches High up to 120 inches High: Four hinges.

2.03 TRACK AND HANGERS

- A Pocket Doors: Provide pocket door kit, including header assembly, split studs, hangers, door hanger plates, bumper, guides, floor plate, and end bracket.
 1. Pocket Door Kit
 - a. Basis of Design: Pemko; an Assa Abloy Group company; PF28200A: www.assaabloydss.com/#sle.
 2. Pull and Locking Hardware
 - a. Basis of Design: EMTEK Products Inc.; Modern Rectangular Mortise Lock; US10B Oil Rubbed Bronze; Single
 - 1) Product: Modern Rectangular Mortise Lock; US10B Oil Rubbed Bronze; Single Cylinder
 - 2) Finish: US10B Oil Rubbed Bronze;
 - 3) Function: Single Cylinder
 - 4) Product Code: 211310B
 3. Substitutions with Architect's approval only.
- B Face-Mounted Barn Door Hardware:
 1. Provide steel, flat track rail, track fasteners, guides, latches and pulls; size rail and hangers in accordance with manufacturer's recommendations for weight of doors.
 2. Track Finish: Black..

3. Hardware: As listed in Section 08 32 10 - Custom Sliding Gate and Fixed Screens.

C Door Weight: Heavy; frequently used opening with up to 1,000 lbs door weight.

2.04 FLUSH BOLTS

A Flush Bolts: Comply with BHMA A156.16, Grade 1.

1. Flush Bolt Throw: 3/4 inch, minimum.
2. Provides extension bolts in leading edge of door, one bolt into floor, one bolt into top of frame.
 - a. Pairs of Swing Doors: At inactive leaves, provide flush bolts of type as required to comply with code.
3. Provide dustproof floor strike for bolt into floor, except at metal thresholds.
4. Self-Latching Flush Bolts: Automatically latch upon closing of door; manually retracted; located on inactive leaf of pair of doors.

2.05 LEVER / LATCH SET TRIM

A Lever / Latch Sets:

1. Manufacturer: Schlage
2. Style: Latitude
3. Finish: Oil Rubbed Bronze

2.06 LOCK CYLINDERS

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

1. Provide standard and conventional type cylinders, Grade 2, with six-pin core in compliance with BHMA A156.5 at locations indicated.
2. Provide cylinders from same manufacturer as locking device.
3. Provide cams and/or tailpieces as required for locking devices.

2.07 CYLINDRICAL LOCKS

A Cylindrical Locks (Bored): Comply with BHMA A156.2, Grade 2.

1. Bored Hole: 2-1/8 inch diameter.
2. Backset: 2-3/4 inch unless otherwise indicated.
3. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
 - a. Finish: To match lock or latch.

2.08 DOOR PULLS AND PUSH BARS

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

1. Bar Type: Bar set, unless otherwise indicated.
 - a. Manufacturer: Emtek; Trinity 12" Pull, Oil Rubbed Bronze
2. Quantity: Provide one pull on each of door leaf.

2.09 CLOSERS

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

1. Type: Surface mounted to door.
2. Finish: Oil Rubbed Bronze or matching paint.
3. Provide door closer on each exterior door.

2.10 DOOR HOLDERS

A Door Holders: Comply with BHMA A156.16, Grade 1.

1. Type: Lever, or kick down stop, with rubber bumper at bottom end.
2. Material: Bronze.

2.11 FLOOR STOPS

- A Floor Stops: Comply with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
1. Type: Manual hold-open, with pencil floor stop.
 2. Material: Bronze housing with rubber insert.

2.12 WALL STOPS

- A Wall Stops: Comply with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
1. Type: Bumper, concave, wall stop.
 2. Material: Bronze housing with rubber insert.

2.13 THRESHOLDS

- A Thresholds: Comply with BHMA A156.21.
1. Provide threshold at each exterior door, unless otherwise indicated.
 2. Type: Flat surface.
 3. Material: Bronze.
 4. Threshold Surface: Fluted horizontal grooves across full width.
 5. Field cut threshold to profile of frame and width of door sill for tight fit.

2.14 WEATHERSTRIPPING AND GASKETING

- A Weatherstripping and Gasketing: Comply with BHMA A156.22.
1. Head and Jamb Type: Adjustable.
 2. Door Sweep Type: Encased in retainer.
 3. Material: Bronze, with brush weatherstripping.
 4. Provide door bottom sweep on each exterior door, unless otherwise indicated.

2.15 GATE LATCH

- A Gate Latch: Provide to secure a gate used for traffic control to prevent pedestrian traffic into an area, located on inside of gate with turn piece.
1. Material: Steel.

2.16 SILENCERS

- A Silencers: Provide at equal locations on door frame to mute sound of door's impact upon closing.
1. Single Door: Provide three on strike jamb of frame.
 2. Pair of Doors: Provide two on head of frame, one for each door at latch side.
 3. Material: Rubber, gray color.

2.17 KEY CONTROL SYSTEMS

- A Key Control Systems: Comply with guidelines of BHMA A156.28.
1. Keying: Grand master keyed.

2.18 FIRE DEPARTMENT LOCK BOX

- A Fire Department Lock Box:
1. Capacity: Holds 10 keys.
 2. Finish: Manufacturer's standard dark bronze.

2.19 FINISHES

- A Finishes: Provide door hardware of same finish, unless otherwise indicated.
1. Primary Finish: 613; dark oxidized satin bronze, oil rubbed, with bronze base material (former US equivalent US10B); BHMA A156.18.

2. Secondary Finish: 626; satin chromium plated over nickel, with brass or bronze base material (former US equivalent US26D); BHMA A156.18.
 - a. Use secondary finish in bathrooms; provide primary finish on one side of door and secondary finish on other side.

2.20 HARDWARE SCHEDULE

- A Hardware Set 1
 1. Latch Set with Classroom Lock
 2. Butt Hinges
 3. Stop
- B Hardware Set 2
 1. Latch Set with Classroom Lock, Active Leaf
 2. Hinges, 180 degree swing, Both Leaves
 3. Dummy Set, Inactive Leaf
 4. Flush Bolts, Inactive Leaf
 5. Install Strike Box on Inactive Leaf
 6. Wall Stop, both Leaves
- C Hardware Set 3
 1. Latch Set with Privacy Lock and Occupancy Designation
 2. Hinges
 3. Stop
- D Hardware Set 4
 1. Pocket Door as outlined herein
- E Hardware Set 5
 1. Barn Door as listed in Section 08 32 10 - Custom Sliding Gate and Fixed Screens
- F Hardware Set 6
 1. Latch Set with Classroom Lock, Active Leaf
 2. Hinges, Both Leaves
 3. Closers, Both Leaves
 4. Dummy Set, Inactive Leaf
 5. Flush Bolts, Inactive Leaf
 6. Install Strike Box on Inactive Leaf
 7. Threshold
 8. Weatherstripping
- G Hardware Set 7
 1. Push Pull Bars
 2. Hinges
 3. Floor Stops
 4. Closers

PART 3 EXECUTION

3.01 INSTALLATION

- A Install hardware in accordance with manufacturer's instructions and applicable codes.
- B Install hardware on fire-rated doors and frames in accordance with applicable codes and NFPA 80.
- C Use templates provided by hardware item manufacturer.

- D Do not install surface mounted items until application of finishes to substrate are fully completed.

3.02 ADJUSTING

- A Adjust hardware for smooth operation.

END OF SECTION 08 71 00

SECTION 08 80 00 GLAZING

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data on Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- B Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.

1.02 QUALITY ASSURANCE

- A Perform Work in accordance with GANA for glazing installation methods. Maintain one copy on site.

1.03 WARRANTY

- A Laminated Glass: Provide a five (5) year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.
- B Heat Soaked Tempered Glass: Provide a five (5) year manufacturer warranty to include coverage for spontaneous breakage of fully tempered glass caused by nickel sulfide (NiS) inclusions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.02 GLASS MATERIALS

- A Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
 - 2. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
- 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.

2.03 GLAZING UNITS

- A Monolithic Interior Vision Glazing:
 - 1. Applications: Interior glazing unless otherwise indicated.
 - 2. Glass Type: Laminated float glass.
 - 3. Tint: Clear.
 - 4. Thickness: 1/2 inch, nominal.
- B Monolithic Safety Glazing: Non-fire-rated.
 - 1. Applications:
 - a. Glazed lites in doors, except fire doors.
 - b. Glazed sidelights to doors, except in fire-rated walls and partitions.
 - c. Other locations required by applicable federal, state, and local codes and regulations.
 - d. Other locations indicated on drawings.
 - 2. Glass Type: Fully tempered safety glass as specified.
 - 3. Tint: Clear.

4. Thickness: 1/2 inch, nominal, or as required in Delegated Design.

C Type G-15 - Glass Shelves:

1. Applications: Locations as indicated on drawings.
2. Tint: Clear.
3. Glass Type: Fully tempered float glass with ground edges and corners; ASTM C1048.
4. Thickness: 1/4 inch, nominal.

2.04 GLAZING COMPOUNDS

- A Butyl Sealant: Single component; ASTM C920 Grade NS, Class 12-1/2, Uses M and A, Shore A hardness of 10 to 20; black color.
- B Type GC-5 - Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.

2.05 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 Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.
- D Glazing Clips: Manufacturer's standard type.

PART 3 EXECUTION

3.01 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

- A Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- B Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- C Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.02 INSTALLATION - DRY GLAZING METHOD (TAPE AND GASKET SPLINE GLAZING)

- A Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- B Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
- C Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.

3.03 INSTALLATION - BUTT JOINT GLAZING METHOD (SEALANT ONLY)

- A Permit sealant to cure then remove foam backer rod, and then apply sealant to opposite side, tool smooth to concave profile.

END OF SECTION 08 80 00

SECTION 09 21 16 GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SUBMITTALS

- A. 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.
- B. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
 - 1. See PART 3 for finishing requirements.
- B. Interior Partitions: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 50-54 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.02 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.
- C. Nonstructural Framing System Components: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
 - 1. Studs: C-shaped with knurled or embossed faces.
 - 2. Runners: U shaped, sized to match studs.
 - 3. Resilient Furring Channels: ½" deep steel sheet members designed to reduce sound transmission. Dietrich RC-Deluxe, no substitutions.
 - 4. Ceiling Channels: C-shaped, slotted.
 - 5. Flexible Track: Flexible framing consisting of adjustable leg straps and pivoting, hinged track brackets designed to provide curved framing assemblies of varying radii.
 - 6. Sill Plate Isolation Pads: Acoustical separation between sole plate and subfloor at Digital Lab
- D. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection and prevent rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100.

2.03 BOARD MATERIALS

- A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - 2. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 - 3. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. At curved walls, multi-layer build-up as needed: 1/2 inch.
 - c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
- B. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
 - 1. Application: Vertical surfaces behind thinset tile, except in wet areas.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. Type: Type X, in locations indicated.
 - 4. Type X Thickness: 5/8 inch.
 - 5. Edges: Tapered.
- C. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Ceilings, unless otherwise indicated.
 - 2. Thickness: 1/2 inch.
 - 3. Edges: Tapered.

2.04 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness 2 inches.
- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- C. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.
 - 1. Architectural Reveal Beads:
 - a. Reveal Depth: 1/2 inch.
 - b. Reveal Width: 1/2 inch.
 - c. Shapes: As indicated on drawings.
- D. Decorative Metal Trim:
 - 1. Material: Extruded aluminum alloy 6063-T5 temper.
 - 2. Finish: Anodized, clear.
 - 3. Type: Profile as selected from manufacturer's standard range.

- E. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
- F. Finishing Compound: Surface coat and primer, takes the place of skim coating.
- G. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.01 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C1007/AISI S220 and manufacturer's instructions.
- B. Resilient Furring Channels:
 - 1. Attach directly to framing using pre-punched holes.
 - 2. Wall installation shall be such that the mounting flange shall be installed down so the weight of the gypsum board pulls the channel away from the stud ensuring improved sound rating.
 - 3. Install lowest row of channel no more than 2-inches from floor.
 - 4. Install highest row of channel not more than 6-inches from the ceiling.

3.02 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.

3.03 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.
- 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. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
- D. Installation on Metal Framing: Use screws for attachment of gypsum board.

3.04 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying 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 or wall coverings and other areas specifically indicated.
 - 2. Level 4: Walls and ceilings to receive paint finish, unless otherwise indicated.
 - 3. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.

END OF SECTION 09 21 16

SECTION 09 63 40 STONE FLOORING

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Provide instructions for using grout.
- B Samples: Mount stone and apply grout on two plywood panels, 12 by 12 inch in size illustrating pattern, color variations, and grout joint size variations.
- C Samples: Submit stone samples for sealant compatibility testing.

1.02 QUALITY ASSURANCE

- A Perform work in accordance with TCNA (HB) instructions for methods specified.

1.03 FIELD CONDITIONS

- A Maintain at least 50 degrees F ambient temperature during installation of flooring materials.

PART 2 PRODUCTS

2.01 STONE

- A Soapstone as indicated in Materials and Finishes Schedule in Drawings for fireplace hearth.
- B Unit Size: As face and slab thicknesses as indicated on Drawings.

2.02 SETTING AND GROUTING MATERIALS

- A Provide setting and grout materials from same manufacturer.
- B Mortar Bed Materials: Portland cement, sand, latex additive, and water.
- C Epoxy Adhesive and Mortar Bond Coat: ANSI A118.3.

2.03 MORTAR AND GROUT MIX

- A Mix and proportion cementitious materials for site made slurry coat and mortar bed.
- B Mix and proportion pre-mixed setting bed and grout materials in accordance with manufacturer's instructions.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A Install stone flooring in accordance with stone fabricator's instructions.
- B Lay stone units to be top slab being dominant with side slabs butt jointed below.

3.02 MORTAR BED METHOD

- A Install in accordance with TCNA (HB) Method F111, over cleavage membrane.

END OF SECTION 09 63 40

SECTION 09 65 00 RESILIENT FLOORING

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- B Shop Drawings: Indicate seaming plans and floor patterns.
- C Verification Samples: Submit three samples, 6 by 6 inch in size illustrating color and pattern for each resilient flooring product specified.

PART 2 PRODUCTS

2.01 SHEET FLOORING

- A Linoleum Sheet Flooring: Homogeneous wear layer bonded to backing, with color and pattern through wear layer thickness.
 - 1. Minimum Requirements: Comply with ASTM F2034, Type corresponding to type specified.
 - 2. Manufacturer, Product and Color: As indicated on Drawings.
 - 3. Backing: Jute fabric.
 - 4. Thickness: 0.100 inch, minimum, excluding backing.
 - 5. Seams: Net Fit Seams.

2.02 TILE FLOORING

- A Vinyl Composition Tile: Homogeneous, with color extending throughout thickness.
 - 1. Minimum Requirements: Comply with ASTM F1066, of Class corresponding to type specified.
 - 2. Manufacturer, Product, Color and Pattern Layout: As indicated on Drawings.
 - 3. Size: 12 by 12 inch.
 - 4. Thickness: 0.125 inch.

2.03 RESILIENT BASE

- A Resilient Base: ASTM F1861, Type TS, rubber, vulcanized thermoset; style as scheduled.
 - 1. Manufacturer, Product, Style and Color: As indicated on Drawings.
 - 2. Height: 4 inches.
 - 3. Thickness: 0.125 inch.
 - 4. Finish: Satin.
 - 5. Length: Roll.

2.04 ACCESSORIES

- A Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
- C Moldings, Transition and Edge Strips: Aluminum Schluter; JOLLY where approved by Architect..
- D Sealer and Wax: Types recommended by flooring manufacturer.

PART 3 EXECUTION

3.01 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.

3.02 INSTALLATION - SHEET FLOORING

- A Lay flooring with joints and seams in accordance with Architect approved seaming diagram. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.

3.03 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.

3.04 INSTALLATION - RESILIENT BASE

- A Fit joints tightly and make vertical. Maintain minimum dimension of 60 inches between joints.

END OF SECTION 09 65 00

SECTION 09 68 13
TILE CARPETING

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- B Shop Drawings: Indicate layout of joints.
- C Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.

PART 2 PRODUCTS

2.01 MATERIALS

- A Tile Carpeting:
 - 1. Manufacturer, Product, Style, Size, Color and Layout: As indicated on Drawings.

2.02 ACCESSORIES

- A Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.
- B Edge Strips: Embossed aluminum, _____ color.
- C Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION

3.01 INSTALLATION

- A Blend carpet from different cartons to ensure minimal variation in color match.
- B Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- C Lay carpet tile in approved direction and pattern.

END OF SECTION 09 68 13

SECTION 09 72 00 WALL COVERINGS

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Provide data on wall covering and adhesive.
- B Shop Drawings: Indicate wall elevations with seaming layout.
- C Digitally Printed Shop Drawings:
 - 1. Include graphics, layouts and dimensions.
- D Samples: Submit three samples of wall covering, 8 by 11 inch in size illustrating color, finish, and texture.
- E Digitally Printed Samples:
 - 1. Provide overall, scaled, mock-up of entire graphic. Provide full-size mock-up, no smaller than 5' wide x 4' high of a portion of the entire graphic.
 - 2. Mock-ups to be in full color on actual substrate with full-sized section printed in same resolution as final.

1.02 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 WALL COVERINGS

- A General Requirements:
 - 1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
 - 2. All Types as indicated on Materials and Finishes Schedule n Drawings.
- B Wall Covering - Type VWC-1, -2, -3, and -4: Fabric-backed vinyl roll stock.
 - 1. Comply with ASTM F793/F793M, Category V, Type II.
- C Wall Covering - Type DWC-1, -2, -3, and -4: Fabric-backed vinyl roll stock, Custom Digitally Printed.
 - 1. Backing: Polyethylene-coated paper.
 - 2. Color: White.
- D Wall Covering: Type WC-1: Acoustic Wallcovering.
- E Adhesive: Type recommended by wall covering manufacturer to suit application to substrate.
- F Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.
- G Substrate Primer and Sealer: Alkyd enamel type.

PART 3 EXECUTION

3.01 INSTALLATION

- A Apply adhesive and wall covering in accordance with manufacturer's instructions.
- B Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface.

- C Butt edges tightly.
- D Overlap adjacent panels as recommended by manufacturer.
- E Horizontal seams are not acceptable.
- F Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

END OF SECTION 09 72 00

SECTION 09 84 30
SOUND-ABSORBING WALL AND CEILING UNITS

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Manufacturer's printed data sheets for products specified.
- B Shop Drawings: Fabrication and installation details, panel layout, fabric orientation, and wood grain orientation.
- C Verification Samples: Fabricated samples of each type of panel specified; 12 by 12 inch, showing construction, edge details, and fabric covering.

PART 2 PRODUCTS

2.01 ACOUSTIC WALL PRODUCTS

- A Provide products indicated on Materials & Finishes Schedule in Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install acoustical units in locations as indicated, following manufacturer's installation instructions.
- B Install mounting accessories and supports in accordance with shop drawings.
- C Align panels accurately, with edges plumb and top edges level. Scribe to fit accurately at adjoining work and penetrations.

END OF SECTION 09 84 30

SECTION 09 91 23 INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Surface preparation and the application of paint systems on the following interior substrates:
 - a. Metal.
 - b. Gypsum board.
 - c. Concrete.
 - 2. Touch up to all painted surfaces, including existing and prefinished items by other sections.

1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Sherwin-Williams Company (The).
 2. Benjamin Moore & Co.
 3. PPG Paints.
 4. Hallman Lindsay Paints.
 5. Pratt & Lambert.
 6. ICI Paints.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 1. Nonflat Paints and Coatings: 150 g/L.
 2. Dry-Fog Coatings: 400 g/L.
 3. Primers, Sealers, and Undercoaters; 200 g/L.
 4. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 5. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 6. Pretreatment Wash Primers: 420 g/L.
 7. Floor Coatings: 100 g/L.

2.3 PRIMERS/SEALERS

- A. Primer Sealer, Interior, Institutional Low Odor/VOC: MPI #149.

2.4 METAL PRIMERS

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

2.5 WATER-BASED PAINTS

- A. Latex, Interior, Institutional Low Odor/VOC, (Gloss Level 3): MPI: #145.
- B. Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (Gloss Level 5): MPI #147.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Wood: 15 percent.
 - 2. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. SSPC-SP 2, "Hand Tool Cleaning".
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Concrete Floor Substrates: SSPC SP-13 to provide a surface profiled of CSP 1-3 (ICRI 310.2R.)

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

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

3.6 INTERIOR PAINTING SCHEDULE

- A. Metal Substrates:
 1. Institutional Low-Order/VOC Latex System, MPI INT 5.1S:
 - a. Prime Coat: Primer, rust-inhibitive, water-based MPI #107.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 5), MPI #147.
- B. Gypsum Board Substrates:
 1. Institutional Low-Odor/VOC Latex System MPI INT 9.2M:
 - a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
- C. Concrete Floor Substrates:
 1. Epoxy System (Water Based):
 - a. Prime Cost: ArmorSeal 8100, reduced one pint of clean water per gallon.
 - b. Intermediate Coat: ArmorSeal 8100, broadcast ArmorSeal Hi-Wear Additive.
 - c. Topcoat: ArmorSeal 8100. (MPI Gloss Level 3).

END OF SECTION 09 91 23

SECTION 09 93 00 STAINING and TRANSPARENT FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and application of wood stains and transparent finishes on the following substrates:
 - 1. Interior Substrates:
 - a. Finish new wood baseboard, railings, custom sliding gates and fixed screens, wood fireplace surround and opposite wall, and interior flush wood doors, to match Architect's sample.
 - b. Other items as noted on plans.

1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
- B. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
- C. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- D. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- E. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of finish system and in each color and gloss of finish required.

1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each finish system indicated and each color selected to verify preliminary selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each type of finish system and substrate.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of stain color selections will be based on mockups.

- a. If preliminary stain color selections are not approved, apply additional mockups of additional stain colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in wood finish systems schedules for the product category indicated.

2.2 MATERIALS, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."
- B. Material Compatibility:
 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. Stain Colors: Match Architect's samples.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.
- C. Maximum Moisture Content of Interior Wood Substrates: **[15]** **[13]** **[10]** **[9]** percent, when measured with an electronic moisture meter.
- D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- E. Proceed with finish application only after unsatisfactory conditions have been corrected.
 1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
 1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.

1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

3.3 APPLICATION

- A. Apply finishes according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
- B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

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

3.5 INTERIOR WOOD -FINISH-SYSTEM SCHEDULE

- A. Wood Substrates: Wood trim and wood board siding.
 1. Alkyd Varnish over Stain System MPI INT 6.3D:
 - a. Stain Coat: Stain, semitransparent, for interior wood, MPI #90.
 - b. First Intermediate Coat: Alkyd, sanding sealer, clear, MPI #102.
 - c. Second Intermediate Coat: Varnish matching topcoat.
 - d. Topcoat: Varnish, interior, semi-gloss (MPI Gloss Level 5), MPI #74.

END OF SECTION 09 93 00

SECTION 10 14 00
APPLIED VINYL LETTER SIGNAGE

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Manufacturer's product literature for initial color selections.
- B Shop Drawings: Include dimensions, locations, elevations, materials, text and graphic layout.
- C Verification Samples: Submit one sample letter in selected color for approval.

PART 2 PRODUCTS

2.01 DIMENSIONAL LETTERS

- A Subject to compliance with requirements, provide the following:
 - 1. Self adhesive vinyl letter signs printed on transfer tape for accurate alignment.
 - 2. Basis of Design: Lettering.com
 - a. Substitutions allowed with approval of the architect.

PART 3 EXECUTION

3.01 INSTALLATION

- A Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B Install in accordance with manufacturer's instructions.
- C Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
- D Locate dimensional letter signs and mount at heights indicated on drawings.
- E Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- F Protect from damage until substantial completion; repair or replace damaged items.

END OF SECTION 10 14 00

SECTION 10 14 19 DIMENSIONAL LETTER SIGNAGE

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Manufacturer's product literature for each type of dimensional letter sign, indicating style, font, colors, locations, and overall dimensions of each sign.
- B Shop Drawings:
 - 1. Include dimensions, locations, elevations, materials, text and graphic layout, and attachment details.
- C Samples: Submit one sample of each type of dimensional letter sign of size similar to that required for project, indicating sign style, font, and method of attachment.
- D Selection Samples: Where materials, colors, and finishes are not specified, submit two sets of selection charts or chips.
- E Verification Samples: Submit samples showing colors and finishes specified.
- F Manufacturer's Installation Instructions: Include installation templates and attachment devices.

PART 2 PRODUCTS

2.01 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.

2.02 DIMENSIONAL LETTERS

- A Subject to compliance with requirements, provide the following:
 - 1. Basis of Design: Gemini Incorporated
 - 2. Acceptable Manufacturers:
 - a. ACE Sign Systems, Inc.
 - b. ASI Sign Systems, Inc.
 - c. Metallic Arts
 - d. Southwell Company (The).
- B Wood Letters:
 - 1. Material: Ash wood to match doors and millwork.
 - 2. Letter Height: As indicated on drawings.
 - 3. Text and Typeface:
 - a. Character Font: As indicated on Drawings..
 - 4. Finish: Semi-gloss.
 - 5. Color: As indicated on Drawings.
 - 6. Mounting: Concealed pad mounts for 1/4" projection from mounting surface..
- C Fabrication:
 - 1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.

2.03 ACCESSORIES

- A Fastener and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined. Use concealed fasteners and anchors unless indicated to be exposed.
- B Temporary Protective Coating: Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 EXECUTION

3.01 INSTALLATION

- A Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B Install in accordance with manufacturer's instructions.
- C Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
- D Locate dimensional letter signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.
- E Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- F Protect from damage until mm-dd-yyyy; repair or replace damaged items.

END OF SECTION 10 14 19

SECTION 10 14 23 PANEL SIGNAGE

PART 1 GENERAL

1.01 SUBMITTALS

- A 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.
- B 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.
- C 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.
- D Selection Samples: Where colors, materials, and finishes are not specified, submit two sets of color selection charts or chips.
- E Verification Samples: Submit samples showing colors, materials, and finishes specified.

1.02 WARRANTY

- A Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
- B Failures include, but are not limited to, the following:
 - 1. Deterioration of finishes beyond normal weathering.
 - 2. Deterioration of embedded
 - 3. Separation of delamination of sheet materials and components.
- C Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 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.

2.02 PANEL SIGNAGE

- A Manufacturers
 - 1. Subject to compliance with requirements, provide products by one of the following:
 - a. ACE
 - b. ASI Sign Systems, Inc.
 - c. Inpro Corporation.
 - d. Vista System.
- B Panel Signage
 - 1. Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles
 - 2. Application: Room and door signs.

3. Description: Flat signs with applied character panel media, tactile characters.
4. Sign Size: As indicated on drawings.
5. Total Thickness: Manufacturer's standard for size of sign.
6. Color and Font, unless otherwise indicated:
 - a. Character Font: As indicated on Drawings.
 - b. Character Case: As indicated on Drawings..
 - c. Background Color: As selected by Architect from full range of industry colors..
 - d. Character Color: Contrasting color.
 - 1) Raised Braille to match background color.
7. Material: Acrylic plastic base with applied plastic letters and braille.
 - a. Acrylic sheet: ASTM D4802, category as standard with manufacturer for each sign, Typ UVF (UV filtering).
8. Flatness tolerance:
 - a. Sign shall remain flat or uniformly curved under installed conditions as indicated on Drawings and within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner.
9. Tactile Letters: Raised 1/32 inch minimum.
10. Braille: Grade II, ADA-compliant.
11. One-Sided Wall Mounting: Tape adhesive.
 - a. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

2.03 ACCESSORIES

- A Temporary Protection: Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B Tape Adhesive: Double-sided tape, permanent adhesive.

2.04 FABRICATION

- A Preassemble signs in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
- B Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
- C Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
- D Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
- E
- F Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- G Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.01 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 Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.

3.03 ADJUSTING AND CLEANING

- A Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION 10 14 23

SECTION 10 26 00 WALL AND CORNER PROTECTION

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.
- B Shop Drawings: Include plans, elevation, sections, and attachment details.
- C Samples: Submit samples illustrating component design, configurations, joinery, color and finish.
 - 1. Submit three samples of protective wall covering, 3 x 3 inches square.

PART 2 PRODUCTS

2.01 PRODUCT TYPES

- A Corner Guards - Flush Mounted:
 - 1. Basis of Design: InPro Architectural Products; 160F Flush Mount Corner Guard
 - 2. Material: High impact vinyl with full height extruded aluminum retainer.
 - 3. Material: Polyethylene terephthalate (PET or PETG); PVC-free with full height extruded aluminum retainer.
 - 4. Performance: Resist lateral impact force of 100 lbs at any point without damage or permanent set.
 - 5. 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.
 - 6. Width of Wings: 2 inches.
 - 7. Corner: Square.
 - 8. Color: As selected from manufacturer's standard colors.
- B Protective Wall Panels:
 - 1. Thickness: 0.075 inch.
 - 2. Panel Size: 3 feet by 8 feet.
 - 3. Color and Pattern: As selected from manufacturer's standard finishes.
 - 4. Texture: As selected from manufacturer's standard textures.
 - 5. Mounting: Adhesive.

2.02 FABRICATION

- A Fabricate components with tight joints, corners and seams.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.
- B Position corner guard with bottom of guard at top of wall base and continuous to ceiling.
- C Position protective wall covering with bottom of panel at top of base.

END OF SECTION 10 26 00

SECTION 10 28 00 TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Provide products of each category type by single manufacturer.
- B Manufacturer
 - 1. Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis of Design: Bobrick
 - a. Unless noted otherwise, model numbers included on based on Bobrick products.
 - 3. Acceptable Manufacturer: Bradley
 - 4. Substitutions with Architect prior approval.

2.02 MATERIALS

- A Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
- B Keys: Provide four keys for each accessory to Owner; master key lockable accessories.
- C All finished materials to be Satin / Brushed type 304 Stainless Steel with welded construction, unless noted otherwise.
 - 1. Stainless Steel Sheet: ASTM A666, Type 304.
 - 2. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
 - 3. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
 - 4. Zinc Alloy: Die cast, ASTM B86.
- D Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
- E Mirror Glass: Tempered safety glass, ASTM C1048; and ASTM C1036 Type I, Class 1, Quality Q2, with silvering as required.

2.03 FINISHES

- A Stainless Steel: Satin finish, unless otherwise noted.
- B Baked Enamel: Pretreat to clean condition, apply one coat primer and minimum two coats epoxy baked enamel.
- C Powder-Coated Steel: Clean, degrease, and neutralize. Follow immediately with a phosphatizing treatment, prime coat, and two finish coats of powder coat enamel.

2.04 COMMERCIAL TOILET ACCESSORIES

- A Toilet Paper Dispenser: Type TA-6; Double roll, surface mounted.
 - 1. Basis of Design: Bobrick; B-4288
- B Combination Towel Dispenser/Waste Receptacle: Type TA-2; Recessed flush with wall, stainless steel; seamless wall flanges, continuous piano hinges.
 - 1. Basis of Design: Bobrick; B-36903

2. Towel dispenser capacity: 400 C-fold.
 3. Waste receptacle capacity: 16 gallons.
- C Soap Dispenser: Liquid soap dispenser, wall-mounted, surface, with stainless steel cover and horizontal stainless steel tank and working parts; push type soap valve, check valve, and window gauge refill indicator, tumbler lock.
1. Basis of Design: Bobrick; B-4112
 2. Minimum Capacity: 40 ounces.
- D Mirrors: Type TA-1; Stainless steel framed, 1/4 inch thick annealed float glass; ASTM C1036.
1. Basis of Design: Bobrick; B-290
 2. Annealed Float Glass: Silvering, protective and physical characteristics in compliance with ASTM C1503.
 3. Size: As indicated on drawings.
 4. Frame: 0.05 inch angle shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.
- E Grab Bars: Type TA-5; Stainless steel, smooth surface.
1. Basis of Design: Bobrick; B-6806 series
 2. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force, minimum.
 - b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
 - c. Finish: Satin.
 - d. Length and Configuration: As indicated on drawings.
- F Sanitary Napkin Disposal Unit: Type TA-7; Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.
1. Basis of Design: Bobrick; B270

2.05 DIAPER CHANGING STATIONS

- A Diaper Changing Station: Wall-mounted folding diaper changing station for use in commercial toilet facilities, meeting or exceeding ASTM F2285.
1. Basis of Design: Koala Kare from Bobrick; KB300
 2. Material: Polyethylene.
 3. Mounting: Surface.
 4. Color: As selected.
 5. Minimum Rated Load: 250 pounds.

END OF SECTION 10 28 00

SECTION 10 31 00 MANUFACTURED FIREPLACES

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Provide firebox cabinet dimensions, clearances required from adjacent dissimilar construction, applicable regulatory agency approvals, and electrical characteristics of fan.
- B Shop Drawings: Indicate layout, elevations, sections, firebox rough opening dimensions, rough opening sizes for chimney flue/vent if required, required clearances, utility service requirements, attachments to other work, and fan size.

1.02 WARRANTY

- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B Manufacturer Warranty: Provide 2-year manufacturer warranty for material defects and operation. Complete forms in Owner's name and register with manufacturer.
- C Installer Warranty: Provide 2-year warranty for installation commencing on Date of Substantial Completion. Complete forms in Owner's name and register with installer.

PART 2 PRODUCTS

2.01 ELECTRIC FIREPLACES

- A Manufacturers:
 - 1. Napoleon; Elevation Electric Fireplace Series (NEFB36H-MF): www.napoleon.com/#sle.
- B Description:
 - 1. Location: Indoor.
 - 2. Fireplace Style: Traditional.
 - 3. Power Connection: Hardwired.
 - 4. Amperage (AMP) and Wattage : Dedicated 15 AMP Grounded Circuit; Max 1465 W for 120 V AC service and 2,930 W with 240 V AC Service.
 - 5. Built-in fireboxes.
 - a. Fully recessed in enclosure.
- C Design Criteria:
 - 1. Comply with UL 2021 for electric room heating equipment.

2.02 COMPONENTS

- A Firebox: Formed insulated steel cabinet with rectangular-shaped interior, configured to include Air Intake Vent and Exhaust Fan.
 - 1. Viewable Opening: See drawings.
 - 2. Firebox Depth: See drawings.
- B Firebox Closure: Fixed clear, tempered glass panel.

2.03 ACCESSORIES

- A Power exhaust fan.

PART 3 EXECUTION

3.01 INSTALLATION

- A Comply with applicable code for clearances from adjacent materials, chimney height above roof line requirements, and unit UL approval.
- B Install unit assembly in accordance with manufacturer's instructions.

END OF SECTION 10 31 00

SECTION 10 44 00 FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Provide extinguisher operational features.
- B Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.

PART 2 PRODUCTS

2.01 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: 2.5 pound.
 - 3. Finish: Baked polyester powder coat, color as selected.
 - 4. Temperature range: Minus 40 degrees F to ___ degrees F.
- C Dry Chemical Type Fire Extinguishers: Stainless steel tank, with pressure gauge.
 - 1. Class: K type.
 - 2. Size: 1.6 gallons.
 - 3. Finish: Polished stainless steel.
 - 4. Temperature range: Minus 20 degrees F to 120 degrees F.

2.02 FIRE EXTINGUISHER CABINETS

- A Basis of Design: Larsens; Vertical Duo.
- B Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
- C Cabinet Construction: Non-fire rated.
 - 1. Formed primed steel sheet; 0.036 inch thick base metal.
- D Fire Rated Cabinet Construction: One-hour fire rated.
 - 1. Steel; double wall or outer and inner boxes with 5/8 inch thick fire barrier material.
- E Cabinet Configuration: Recessed type.
 - 1. Trimless type.
- F Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- G Door Glazing: Acrylic plastic, clear, 1/8 inch thick, flat shape and set in resilient channel glazing gasket.
- H Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- I Finish of Cabinet Exterior Trim and Door: Baked enamel, Match Architect's sample for color.
- J Finish of Cabinet Interior: White colored enamel.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.

- B Install cabinets plumb and level in wall openings, maximum 40" inches from finished floor to centerline of handle.
- C Secure rigidly in place.
- D Place extinguishers in cabinets.

END OF SECTION 10 44 00

SECTION 11 30 13 RESIDENTIAL APPLIANCES

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Manufacturer's data indicating dimensions, capacity, and operating features of each piece of residential equipment specified.

1.02 QUALITY ASSURANCE

- A Electric Appliances: Listed and labeled by UL (DIR) and complying with NEMA Standards (National Electrical Manufacturers Association).

1.03 WARRANTY

- A Provide five (5) year manufacturer warranty on refrigeration system of refrigerators.
- B Provide ten (10) year manufacturer warranty on magnetron tube of microwave ovens.
- C Provide ten (10) year manufacturer warranty on tub and door liner of dishwashers.

PART 2 PRODUCTS

2.01 KITCHEN APPLIANCES

- A **Refrigerator**, at Demo Kitchen: Free-standing, bottom-mounted freezer, and frost-free.
 - 1. Model: LG; LRDCS2603S; 33 in. wide 26 cu.ft. Bottom Freezer w/ Multi-Air Flow and Smart Cooling in PrintProof Stainless Steel.
 - 2. Capacity: Total minimum storage of 25.5 cubic ft; minimum 32 percent freezer capacity.
 - 3. Energy Usage: Energy Star qualified by energy efficiency standards set by U.S. Department of Energy (DOE).
 - 4. Features: Include glass shelves, automatic icemaker, light in freezer compartment, and internal ice maker with removable bin / basket..
- B **Refrigerator**, at Staff Room: Free-standing, bottom-mounted freezer, and counter-depth.
 - 1. Model: GE Energy Star; GLE12HSPSS-Stainless Steel; 11.9 cu.ft. Bottom-Freezer Refrigerator.
 - 2. Capacity: Total minimum storage of 11.9 cubic ft capacity.
 - 3. Energy Usage: Energy Star qualified by energy efficiency standards set by U.S. Department of Energy (DOE).
- C **Cooktop**, at Demo Kitchen: Induction, with glass-ceramic cooktop.
 - 1. Model: GE Profile; PHP9036DTBB - Black on Black; 36" Built-In Touch-Control Induction Cooktop
 - 2. Size: 36 inches wide.
 - 3. Elements: Five (5).
 - 4. Features: Include Power Boil, Precision Temperature Control, and Chef Connect..
 - 5. Exterior Finish: Porcelain enameled steel, color Black on Black.
- D **Wall Oven**, at Demo Kitchen: Electric, single oven.
 - 1. Model: Cafe; CTS70DP2NS1; Professional Series 30" Built-In Single Electric Convection Wall Oven
 - 2. Size: 30 inches wide.
 - 3. Oven: European Convection with Direct Air.
 - 4. Controls: 7" Full-Color Touch LCD Screen.
 - 5. Features: Include oven door window, oven light, and temperature probe.
 - 6. Exterior Finish: Stainless Steel color appearance.

- E **Microwave**, at Demo Kitchen: In-Wall.
 - 1. Model: Cafe; CWB713P2NS1; Built-In Microwave/Convection Oven
 - 2. Capacity: 1.7 cubic ft.
 - 3. Power: 975 watts.
 - 4. Features: Include turntable and Glass Touch controls.
 - 5. Exterior Finish: Stainless Steel color appearance with Cafe Pro Style Handle.
- F **Dishwasher**, at Demo Kitchen: Undercounter.
 - 1. Model: Bosch; SHE41CM5N - 300 Series Stainless Steel; 24" Recessed Handle Dishwasher
 - 2. Controls: Solid state electronic.
 - 3. Features: Include rinse aid dispenser and PureDry.
 - 4. Finish: Stainless steel .

2.02 LAUNDRY APPLIANCES

- A Clothes Washer, Dryer: Front-loading, Tower Unit
 - 1. Model: LG Laundry; WKHC25H_A; Single Unit LG WashTower with Center Control Front Load Washer and Electric Ventless Heat Pump Dryer
 - 2. Size: 5.0 cu. ft. Washer with 7.8 cu. ft. Dryer.
 - 3. Controls: Solid state electronic.
 - 4. Features: Include bleach dispenser, fabric softener dispenser, self-cleaning lint filter, end of cycle signal, and Wrinkle Care.
 - 5. Finish: Painted steel , color Black.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Anchor built-in equipment in place.

END OF SECTION 11 30 13

SECTION 11 51 16 LIBRARY SPECIALTIES

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Material data for each product specified..
- B Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials using full-scale details..
- C Quality Control Submittals: Manufacturer's Instructions including those for inspection, preparation and installation requirements..
- D Contract Closeout Submittals:
 - 1. Operation and Maintenance Data. Provide schedule of instructions for inspection and routine maintenance procedures.
 - 2. Warranty.

1.02 DELIVERY, STORAGE AND HANDLING

- A Delivery: Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and or mixing with other components.

1.03 PROJECT SITE CONDITIONS

- A Field Measurements.
 - 1. Field verify locations and dimensions of items critical to the design, fit or assembly of the Work in this section. Complete field dimensioning prior to fabrication of components.
 - 2. Verify that field measurements are as indicated on shop drawings.

1.04 WARRANTY

- A General Warranty: Warranties specified in this Article shall not deprive the Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Document
- B Manufacturer Warranty: Provide 2-year manufacturer warranty for material and labor defects in the installed system and components. Complete forms in Owner's name and register with manufacturer. Warranty period shall commence on the date of Substantial Completion.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A Thru-wall Drop Box for Returns.

2.02 MANUFACTURER

- A Manufacturers:
 - 1. Kingsley Equipment Company, Pomona, CA.
- B Description:
 - 1. Product: Ease SingleDrop ThruWall.
 - 2. Model: 10-8100-P
 - 3. Exterior Material / Finish: Satin Stainless Steel type 304 with silk screen letters.
 - a. Text:



4. Interior Material / Finish: Aircraft grade aluminum body with line grain finish, including 13-inch four-sided chute housing. Airbloc neoprene rubber panels. Equipped with Depository door that is gravity and weight balanced to automatically close after materials have passed through.
 5. Locking Method: Depository door locks from inside with rotating locking rod mechanism. Operated by an easy to use knob.
 6. Optional Components / Accessories: Provide Extension for wall thickness and other components as required for complete and usable installation as detailed on Drawings.
- C Product: 40 QuietDrop Under Counter Cart
1. Model: 37-9040
 2. Material / Finish: Aircraft grade aluminum body with durable felt padding at the bottom of the float tray and on the inner walls to help protect collections from damage and reduce noise of collections being deposited.
 3. Optional Components / Accessories: Provide Caster assembly including 5" dia. corner mount casters; two swivel (locking) and two rigid, non-marring, plate mounted and ball bearing.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's written instructions.
- B Install equipment plumb and true.
- C Conceal fastenings where exposed to view.
- D Fit trim cover pieces accurately and tight to adjacent construction.

3.02 CLEANING

- A Repair damaged and defective Work, where possible, to eliminate functional and visual defects; where not possible to repair, replace Work. Adjust for uniform appearance.
- B Clean, lubricate and adjust hardware.
- C Protect installed work from subsequent operations.

END OF SECTION 11 51 16

SECTION 12 24 00 WINDOW SHADES

PART 1 GENERAL

1.01 SUBMITTALS

- A Product Data: Provide manufacturer's standard catalog pages and data sheets for each product to be used including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
 - 1. Motorized Shades: Include power requirements and standard wiring diagrams solely for the specified products.
- B Shop Drawings: Include shade schedule indicating size, location and keys to details.
 - 1. Motorized Shades: Include one-line diagrams, wire counts, coverage patterns, and physical dimensions of each item. Include location plan showing all switch and control zones, switches, sensors and other control accessories.
- C Selection Samples: Include fabric samples in full range of available colors and patterns.
- D Verification Samples: Minimum size 6 inches square, representing actual materials, color and pattern.

1.02 WARRANTY

- A Provide manufacturer's standard, non-depreciating warranty, for interior shading only, covering the following:
 - 1. Shade Hardware: 10 years unless otherwise indicated.
 - a. Mecho /5 with ThermoVeil, EuroVeil, EuroTwill, Soho, Equinox, Midnite, Chelsea, or Classic Blackout shade fabric: 25 years.
 - b. ElectroShade with ThermoVeil, EuroVeil, EuroTwill, Soho, Equinox, Midnite, Chelsea, or Classic Blackout shade fabric: 25 years.
 - 2. Shade Fabric: 10 years unless otherwise indicated.
 - 3. Electric Motors, Controls, and Accessories: Five years.

PART 2 PRODUCTS

2.01 ROLLER SHADES

- A General:
 - 1. Provide shade system components that are capable of being removed or adjusted without removing mounted shade brackets or cassette support channel.
 - 2. Provide shade system that operates smoothly when shades are raised or lowered.
 - 3. Electrical Components: Listed, classified, and labeled as suitable for the purpose intended. Individual testing of components will not be acceptable in lieu of system testing. Where applicable, system components to be FCC compliant.
- B Basis of Design - Roller Shades RS-1: MechoShade Systems LLC; Mecho/5 System: www.mechoshade.com/#sle.
 - 1. Description: Single roller, manually operated fabric window shades.
 - a. Provide universal drive capability to offset drive chain for reverse roll or regular roll shades.
 - b. Mounting: Ceiling mounted.
 - 2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 - 3. Roller Tubes:

- a. Material: Extruded aluminum.
 - b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
 - c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
 - d. Roller tubes to be capable of being removed and reinstalled without affecting roller shade limit adjustments.
4. Hembars: Designed to maintain bottom of shade straight and flat.
 5. Clutch Operator: Manufacturer's standard material and design integrated with bracket/brake assembly.
 - a. Provide a permanently lubricated brake assembly mounted on a oil-impregnated hub with wrapped spring clutch.
 - b. Brake must withstand minimum pull force of 50 pounds in the stopped position.
 - c. Mount clutch/brake assembly on the support brackets, fully independent of the roller tube components.
 6. Drive Chain: Continuous loop stainless steel beaded ball chain, 95 pound minimum breaking strength. Provide upper and lower limit stops.
 - a. Chain Retainer: Chain tensioning device complying with WCMA A100.1.
- C Basis of Design - Roller Shades Type RS-2: MechoShade Systems LLC; ElectroShade with iQ2-AC EDU, line voltage, 120 VAC: www.mechoshade.com/#sle.
1. Description: Single roller, motor operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and accessories.
 - a. Mounting: Ceiling mounted.
 2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 3. Roller Tubes:
 - a. Material: Extruded aluminum.
 - b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
 - c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
 4. Hembars: Designed to maintain bottom of shade straight and flat.
- D Basis of Design - Roller Shades Type RS-3: MechoShade Systems LLC; UrbanShade Double Roller - Motorized, with wireless control: www.mechoshade.com/#sle.
1. Description: Double roller, motor operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and accessories.
 - a. Mounting: Ceiling mounted.
 2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 - a. Double Roller Brackets: Configured for light-filtering and room-darkening shades in one opening.

3. Roller Tubes:
 - a. Material: Extruded aluminum.
 - b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
 - c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
4. Hembars: Designed to maintain bottom of shade straight and flat.
 - a. Room-Darkening Shades: Provide a slot in bottom bar with wool-pile light seal.

2.02 SHADE FABRIC

- A Fabric for Light Filtering Shades: Non-flammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
 1. Material Composition:
 - a. PVC coated polyester yarns.
 - b. 100 percent polyester.
 - c. 100 percent TPO coated polyolefin yarn.
 2. Openness Factor: 3%, nominal.
 3. Color: As selected by Architect from manufacturer's full range of colors.
- B Fabric for Black-Out: Non-flammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
 1. Material Composition:
 - a. PVC coated polyester yarns.
 - b. 100 percent polyester.
 - c. 100 percent TPO coated polyolefin yarn.
 2. Color: As selected by Architect from manufacturer's full range of colors.
 3. Products:
 - a. MechoShade Systems LLC Inc; Soho - 1100 Series (1% open): www.mechoshade.com/#sle.

2.03 INTELLIGENT ENCODED ELECTRONIC DRIVE SYSTEM

- A Electronic Drive Unit (EDU) System - General Requirements:
 1. Provide system listed as complying with UL 325. Recognized component certification is not acceptable in lieu of system testing. Provide listing label and motor rating readily visible for inspection without requiring dismounting of shade assembly for motor or removal of EDU from shade roller tube.
 2. Size and Configuration: As recommended by manufacturer for type, size, and arrangement of shades to be operated.
 3. Conceal EDU inside shade roller tube.
 4. Use EDUs rated at same nominal speed for shades in same room.
 5. Total hanging weight of shade band not to exceed 80 percent of rated lifting capacity of shade EDU and tube assembly.
 6. Capable of upgrading firmware from anywhere on network without touching motor.
- B Line-Voltage EDU, 120 VAC:
 1. Basis of Design: MechoShade Systems LLC; IQ2-AC: www.mechoshade.com/#sle.

2. Description: Tubular, asynchronous, with integral AC motor and reversible capacitor operating at 120 VAC, single phase, 60 Hz; temperature Class B, thermally protected, totally enclosed, maintenance-free; powered by line-voltage power supply connection equipped with locking disconnect plug assembly furnished with EDU.
3. Audible Noise: 46 dBA or less measured 3 feet from motor unit, depending on motor torque.
4. Nominal Speed: Minimum of 34 rpm; does not vary due to load/lift capacity.
5. Provide isolated, low-voltage power supply for powering external accessories connected to either dry contact port or network port. Products that require accessories to be powered by plug-in or externally supplied power supply are not acceptable.

C Modes of Operation:

1. Uniform Mode: Move shades only to defined intermediate stop positions to maintain aesthetic uniformity.
2. Normal Mode: Move shades to defined intermediate stop positions plus any position between defined upper and lower limits.
3. Maintenance Mode: Prevent shade from moving to newly commanded positions via dry contact or network control commands until EDU has been serviced or Maintenance Mode has been cleared or disabled.

D Local Switch Presets:

1. Provide minimum of three customizable preset positions accessible over local dry contact control inputs and over network connection.
2. Preset positions customizable to any position between and including defined upper and lower limits, initially defaulting to 25, 50, and 75 percent of shade travel.
3. Support configuration of custom preset positions using handheld removable program configurator, or local switch.

2.04 MOTOR CONTROLS

- A Unless specifically indicated to be excluded, provide required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, and system programming necessary for complete operating system that provides control intent indicated.
- B Provide components and connections necessary to interface with other systems as indicated.
- C Low-Voltage Wall Controls; IQ Switch:
1. Momentary dry contact switch enables manual local control or network control of individual shade motors, shade groups, or shade subgroups on MechoNet network.
 2. Control Functions:
 - a. Open: Automatically open controlled shades to fully open position when button is pressed.
 - b. Close: Automatically close controlled shades to fully closed position when button is pressed.
 - c. Presets: For selection of predetermined shade positions.
 3. Finish: White.
 4. Products:
- D Power Panels:
1. Basis of Design: MechoShade Systems LLC; WhisperShade IQ2-DC Power Panel.
 2. Provide centralized Class 2 power distribution to each shade and serve as physical layer repeater for MechoNet.

3. Power Input: 100 to 240 VAC, 60 Hz, 5.9 A at 115 VAC.
4. Power Output: 24 VDC plus 2.6 VDC or minus 1.0 VDC, 21 A, with 10 motor connections individually fused.
5. Enclosure: Secured, locking Type 1; 12 inches wide by 12 inches high by 6 inches deep.
6. Provide configurable dry contact switch input.
7. Support third-party integration via RS232.
8. Provide MechoNet serial communication ports.

PART 3 EXECUTION**3.01 INSTALLATION**

- A Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.
- B Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.02 CLOSEOUT ACTIVITIES

- A Demonstration: Demonstrate operation and maintenance of window shade system to Owner's personnel.

END OF SECTION 12 24 00

SECTION 12 36 00 COUNTERTOPS

PART 1 GENERAL

1.01 SUBMITTALS

- A Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections.
- B Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.

PART 2 PRODUCTS

2.01 COUNTERTOPS

- A Quality Standard: Premium 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. Finish: Matte or suede, gloss rating of 5 to 20.
 - b. Surface Color and Pattern: As indicated on drawings.
 - 2. Exposed Edge Treatment: Hardwood Edge-banding, exposed at edge only as indicated on drawings, natural spar varnish finish.
 - 3. Back and End Splashes: Not applicable.
- 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. NSF approved for food contact.
 - b. Sinks and Bowls: Separate units for undercounter mounting; minimum 3/4 inch wall thickness; comply with IAPMO Z124.
 - c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
 - d. Color and Pattern: As indicated on drawings.
 - 3. Other Components Thickness: 1/2 inch, minimum.
 - 4. Back and End Splashes: Not applicable.
 - 5. Fabricate for Window Stools.
 - 6. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.
- 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, total thickness, including substrate, 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. NSF approved for food contact.
- b. Sinks: Separate units for undercounter mounting; minimum 3/4 inch wall thickness; comply with IAPMO Z124.
- c. Finish on Exposed Surfaces: Polished.
- d. Color and Pattern: As indicated on drawings.

2.02 HARDWARE AND ACCESSORIES

- A Counter Support Brackets
 1. Rakks 1-800-826-6006
 2. Material: Anodized Aluminum
 3. Configuration: Flush Mount
 4. Size: To match counter depth

2.03 MATERIALS

- A 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.
- B Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

2.04 FABRICATION

- A Fabricate tops in the largest sections practicable, with top surface of joints flush.
- B Back/end splashes are not applicable to this project.
- C Solid Surfacing: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
 1. Integral sinks: Shop-mount securely to countertop with adhesives, using flush configuration, as per manufacturer's instructions, and as detailed on drawings.
- D Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings.

PART 3 EXECUTION

3.01 INSTALLATION

- A Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
- C Scribe all joints between walls and countertops.

END OF SECTION 12 36 00

SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SCOPE

A This section includes information common to two or more technical fire protection specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Protection of Finished Surfaces.
 - g. Sleeves and Openings.
 - h. Sealing and Firestopping.
 - i. Codes.
 - j. Design Criteria.
 - k. Certificates and Inspections.
 - l. Submittals.
 - m. Operating and Maintenance Instructions.
 - n. Training of Owner Personnel.
 - o. Record Drawings.
2. PART 2 – PRODUCTS.
 - a. Access Panels and Doors.
 - b. Identification.
 - c. Sealing and Firestopping.
3. PART 3 – EXECUTION.
 - a. Concrete Work.
 - b. Cutting and Patching.
 - c. Building Access.
 - d. Equipment Access.
 - e. Coordination.
 - f. Identification.
 - g. Lubrication.
 - h. Sleeves and Openings.
 - i. Sealing and Firestopping.
 - j. Owner Training.

1.02 RELATED WORK

- A This section applies to all Division 22 sections of fire suppression.
- B Section 07 84 00 - Firestopping

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A Abbreviations of standards organizations referenced in this, and other sections are as follows:
 1. AGA American Gas Association.
 2. ANSI American National Standards Institute.
 3. ASME American Society of Mechanical Engineers.
 4. ASPE American Society of Plumbing Engineers.
 5. ASTM American Society for Testing and Materials.
 6. AWWA American Water Works Association.
 7. AWS American Welding Society.
 8. CGA Compressed Gas Association.
 9. CS Commercial Standards, Products Standards Sections, Office of Engineering Standards Service, NBS.
 10. EPA Environmental Protection Agency.
 11. FM FM Global
 12. FS Federal Specifications, Superintendent of Documents, U.S. Government Printing Office.
 13. IAPMO International Association of Plumbing & Mechanical Officials.
 14. IEEE Institute of Electrical and Electronics Engineers.
 15. ISA Instrument Society of America.
 16. DSPS State of Wisconsin Dept. of Safety and Professional Services.
 17. MCA Mechanical Contractors Association.
 18. MICA Midwest Insulation Contractors Association.
 19. MSS Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
 20. NBS National Bureau of Standards.
 21. NEC National Electric Code.
 22. NEMA National Electrical Manufacturers Association.
 23. NFPA National Fire Protection Association.
 24. STI Steel Tank Institute.
 25. UL Underwriters Laboratories Inc.

1.05 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B All products and materials used are to be new, undamaged, clean and in good condition. Existing products and materials are not to be reused unless specifically indicated.

- C Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the intended performance from the system into which these items are placed.

1.06 PROTECTION OF FINISHED SURFACES

- A Refer to Division 1, General Requirements for Protection of Finished Surfaces.

1.07 SLEEVES AND OPENINGS

- A Refer to Division 1, General Requirements for Sleeves and Openings.

1.08 SEALING AND FIRESTOPPING

- A Sealing and firestopping of sleeves/openings between piping, etc. and the sleeve or structural opening shall be the responsibility of the Contractor whose work penetrates the opening. The Contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with Section 07 84 00 - Fire Stopping.

1.09 CODES

- A Comply with requirements of Wisconsin Administrative Code, Dept. of Safety and Professional Services, NFPA Standards and local Fire Chief or Fire Marshal (AHJ, Authority Having Jurisdiction) regarding design, materials and installation.

1.10 DESIGN CRITERIA

- A Design fire protection systems in accordance with codes, standards and regulations noted above.
- B Hydraulically design system for the most remote area based on the following:

<u>Location</u>	<u>Occupancy Classification</u>	<u>Area (SqFt)</u>	<u>Density (GPM/SqFt)</u>
Offices, Meeting Rooms, Library Area (except large stack areas), Combustible Concealed Spaces	Light Hazard	1500	0.10
Storage Rooms, Kitchen Mechanical Room,	Ordinary Group I	1500	0.15
Library large stack areas	Ordinary Group II	1500	0.20

- C Remote area increase for drypipe/Preaction systems and other circumstances i.e. sloped, or higher ceilings are to be added to the minimum remote areas noted above as required by code. Remote area reductions for use of quick response sprinkler heads is not allowed without prior approval of the Engineer and Owner.

- D Available water supply data for system design is as follows:

Test Date: 2014

Performed By: City of Ashland

<u>Hydrant Location</u>	<u>Flow GPM</u>	<u>Static PSI</u>	<u>Residual PSI</u>
3 rd St W and Vaughn Ave	1200	58	42

- E Water test data is preliminary for bidding purposes. Verify and obtain any additional test data required for design. Tests to be representative of high water use periods.

1.11 CERTIFICATES AND INSPECTIONS

- A Refer also to the General Conditions for Permits, Regulations, Utilities and Taxes.

- B Obtain and pay for all required State or local installation inspections except those provided by the Engineer. Deliver originals of NFPA test certificates and test reports to the Division's construction representative. Include copies of the certificates and reports in the Operating and Maintenance Instructions.

1.12 SUBMITTALS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Shop drawing submittals are to be bound, labeled, contain the project manual cover page and a material index list page showing item designation, manufacturer and additional items supplied with the installation. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Include wiring diagrams of electrically powered equipment.
- C The specific items that will be required for submittals shall be coordinated with the Owner, the Engineer, and the General Prime Contractor for inclusion in the project submittal log.
- D Plan submittal for review and approval to the Department of Safety and Professional services is required for all state buildings with the exception of the replacement in kind of equipment and projects that include 20 or fewer sprinkler heads. Submittals shall be sent to the local Fire Chief or Fire Marshal for review prior to the Engineer. Include copy of all review/approval letters in submission to Engineer.
- E Submit plans indicating water supply location and size, piping layout and size, sprinkler locations and type, hanger locations and type, equipment locations and type, valve locations and type, occupancy classes, hydraulic reference points, design areas and discharge densities.
- F Submit hydraulic calculations for water supply and sprinkler systems. Include summary sheet and detailed work sheets. Describe characteristics of water supply and location of effective point used in calculations. Include graph illustration of water supply, hose demand, sprinkler demand and in-rack sprinkler demand. Where a fire pump is used, graph primary rating point, secondary rating point and churn pressure of pump and combined water supply.

1.13 OPERATING AND MAINTENANCE INSTRUCTIONS

- A All operations and maintenance data shall comply with the submission and content requirements specified under section Division 1, General Requirements.
- B In addition to the general content specified under Division 1, General Requirements supply the following additional documentation:
 - 1. Engineer and commissioning provider to define detailed operation and maintenance data requirements for equipment specifications added to this section.
 - a. Copies of all approved submittals along with approval letters.
 - b. Manufacturer's wiring diagrams for electrically powered equipment.
 - c. Records of tests performed to certify compliance with system requirements.
 - d. Certificates of inspection by regulatory agencies.
 - e. Parts lists for equipment and specialties.
 - f. Manufacturers installation, operation and maintenance recommendations for equipment and specialties.
 - g. Valve schedules.

- h. Lubrication instructions, including list/frequency of lubrication.
- i. Warranties.
- j. Additional information as indicated in the technical specification sections.

1.14 TRAINING OF OWNER PERSONNEL

- A Instruct Owner's personnel in the proper operation, maintenance and testing of systems and equipment provided as part of this project. Include not less than 2 hours of instruction, using the Operating and Maintenance manuals and record drawings during this instruction. Demonstrate testing, startup and shutdown procedures for all equipment. All training to be during normal working hours. Video record all instructions and provide Owner with copy.

1.15 RECORD DOCUMENTS

- A Refer to Division 1, General Requirements for Record Documents.
- B In addition to the data indicated in the General Requirements, maintain fire protection layout record drawings and hydraulic calculations on originals prepared by the installing Contractor/Subcontractor. Include copies of these record drawings and calculations with the Operating and Maintenance manuals.

PART 2 PRODUCTS

2.01 ACCESS PANELS AND DOORS

- A Lay-in Ceilings:
 - 1. Removable lay-in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Division 09 are sufficient; no additional access provisions are required unless specifically indicated.
- B Gypsum Board Walls and Ceilings:
 - 1. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers, and similar wet areas, concealed hinges, screwdriver operated cam latch for general applications, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needing service; minimum size is 12" by 12".

2.02 IDENTIFICATION

- A STENCILS:
 - 1. Not less than 1/2 inch high letters for pipe sizes 1" through 2-1/2" and 1 inch high letters/numbers for pipe sizes 3" and above for marking pipe and equipment. Apply flow arrows to piping.
- B ADHESIVE LABELS:
 - 1. Pressure-sensitive, adhesive backed, vinyl pipe markers with applicable labeling, 3/4" min. size for lettering and surrounding tape on both ends. With flow arrows on piping. Conforming to ANSI, ANSI and NFPA standards. Clean piping before application.
 - 2. Manufacturers:
 - a. Seton; Opti-Code: www.seton.com.
 - b. MSI: www.msi-signs.com.
 - c. Brady: www.bradyid.com.
 - d. Brimar Industries, Inc.: www.pipemarker.com.

C SNAP-AROUND MARKERS:

1. One-piece, pre-formed, vinyl construction, snap-around or strap-around pipe markers with applicable labeling, 3/4 inch min. size for lettering. Provide nylon ties on each end of pipe marker.
2. Manufacturers:
 - a. Seton; Setmark: www.seton.com.

D SIGNS:

1. Metal construction, baked porcelain enamel finish signs, sizes conforming to NFPA no. 13 and 7-1.2, with holes and s-hooks/chains for hanging or securing. With applicable labeling.
2. Manufacturers:
 - a. MSI: www.msi-signs.com.
 - b. Seton: www.seton.com.
 - c. W.H. Brady: www.bradyid.com.
 - d. Brimar Industries, Inc.: www.safetysign.com.

E ENGRAVED NAME PLATES:

1. White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting.
2. Manufacturers:
 - a. Seton Name Plate Company; Setonply Style 2060: www.seton.com.
 - b. EMED Co.; Emedolite Style EIP: www.emedco.com.
 - c. Brimar Industries, Inc.: www.pipemarker.com.
 - d. Or equal by W. H. Brady: www.bradyid.com.

F VALVE TAGS:

1. Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains with brass "S" hooks or one piece nylon ties around the valve stem.
2. Manufacturers:
 - a. EMED Co.: www.emedco.com.
 - b. Seton Name Plate Company: www.seton.com.
 - c. MSI: www.msi-signs.com.
 - d. W.H. Brady: www.bradyid.com.
 - e. Brimar Industries, Inc.: www.pipemarker.com.

2.03 SEALING AND FIRESTOPPING

A FIRE AND/OR SMOKE RATED PENETRATIONS:

1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with Section 07 84 00 - Firestopping.

B NON-RATED PENETRATIONS:

1. Pipe Penetrations Through Below Grade Walls:
 - a. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the cored opening or a water-stop type wall sleeve. The operating bolts of the mechanical type seal shall be accessible from the building interior.
2. Pipe Penetrations:
 - a. At pipe penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required, use urethane caulk in annular space between pipe insulation and wall material.

PART 3 EXECUTION

3.01 CONCRETE WORK

- A Cast-in-place concrete within the building will be performed by the Division 3 Contractor. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support or installation of plumbing piping, fixtures, specialties and equipment. Coordinate locations of equipment, pipe penetrations in wet areas, etc. with the Division 3 Contractor.

3.02 CUTTING AND PATCHING

- A Refer to Division 1, General Requirements for Cutting and Patching.

3.03 BUILDING ACCESS

- A Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.04 EQUIPMENT ACCESS

- A Install all piping, conduit and accessories to permit access to equipment for maintenance and service. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Access doors in general construction are to be furnished by the Fire Protection Contractor and installed by the General Contractor.
- B Provide color coded thumb tacks or screws, depending on the surface, for use in accessible ceilings which do not require access panels.

3.05 COORDINATION

- A Coordinate all work with other Contractors prior to installation. Any work that is not coordinated and that interferes with other Contractor's work shall be removed or relocated at the installing Contractor's expense.
- B Verify that all devices are compatible for the type of construction and surfaces on which they will be used.

3.06 IDENTIFICATION

- A Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion.
- B Where stenciling is not appropriate for equipment identification, engraved name plates may be used.

- C Identify interior piping mains not less than once every 25 feet, not less than once in each room, adjacent to each access door or panel, and on both sides of the partition where exposed piping passes through walls or floors. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a light background or white enamel against a dark background, or approved pipe marking label systems, or provide snap-around type pipe markers as specified in Part 2 – Products.
- D Identify valves with signs per NFPA rulings.
- E Provide hydraulic design information sign of permanently marked weatherproof metal or engraved nameplate material. Secure to alarm valve with brass chain. Information to include location of the design areas, discharge densities, required flow and residual pressure at the base of riser, hose stream demand and sprinkler demand.

3.07 LUBRICATION

- A Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by the Owner. Maintain a log of all lubricants used and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

3.08 SLEEVES AND OPENINGS

- A Pipe penetrations in new poured concrete horizontal construction requiring F and T rating: Form opening using hole form or core drill opening. Alternatively provide cast in place fire stopping devices/sleeves. Pipe penetrations in new poured concrete horizontal construction requiring F rating but no T rating: Same as pipe penetrations in new poured concrete construction requiring F and T ratings except that schedule 40 steel sleeves may also be used.
- B Pipe penetrations in new poured concrete horizontal construction that do not require F or T ratings: Provide schedule 40 steel pipe sleeve, form opening using hole form or core drill opening.
- C Pipe penetrations in existing concrete floors: Core drill openings.
- D Pipe penetrations through existing floors located in food service areas that do not require a T rating: Core drill sleeve opening large enough to insert schedule 40 sleeve, extend sleeve 2 inches above the floor and grout area around sleeve with hydraulic setting, non-shrink grout. Size sleeve to allow insulated pipe to run through sleeve and paint the sleeve.
- E Where penetrating pipe or conduit weight is supported by floor, provide manufactured product or structural bearing collar designed to carry load.

3.09 SEALING AND FIRESTOPPING

- A FIRE AND/OR SMOKE RATED PENETRATIONS:
 - 1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with Section 07 84 00 - Fire Stopping.
- B NON-RATED PARTITIONS:
 - 1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with manufacturer's instructions. The bolt heads for the mechanical seal shall face the inside of the building to facilitate repair or replacement of the seal.
 - 2. At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.

C PENETRATIONS SUBJECT TO WATER INTRUSION:

1. For penetrations (both rated and non-rated) in floors subject to water intrusion or in rooms housing electrical equipment (but not within walls) provide one of the following:
 - a. Pipe penetration where steel pipe sleeve is used extend steel sleeve 2 inches above the floor.
 - b. Pipe penetration where cast in place fire stopping device/sleeve is used, extend device/sleeve 2 inches above the floor (provided it meets the device's UL listing).
 - c. Pipe penetration where there is no steel sleeve or cast in place fire stopping device/sleeve, provide 2" x 2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8 inch on center. Seal corners water tight with urethane caulk.
 - d. Duct penetrations. Provide 2" x 2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8 inch on center. Seal corners water tight with urethane caulk.
2. Floors subject to water intrusion or rooms housing electrical equipment include the following locations:
 - a. Food Service/Kitchen Areas.
 - b. Restrooms.
 - c. Janitor Rooms w/ Sinks.
 - d. Mechanical/Plumbing Equipment Rooms.
 - e. Data/Telecommunications Rooms.
 - f. Electrical Equipment Rooms.

- D Provide waterproof caulk sealant top coating on fire stopping system (or other approved means to protect the fire stopping system from water) in areas subject to wash down such as Food Service and Dish Washing Areas.

3.10 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines.

END OF SECTION 21 05 00

INTENTIONALLY LEFT BLANK

SECTION 21 05 29

HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

A This section includes specifications for support of all fire suppression equipment and materials as well as piping system anchors. Included are the following topics:

1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Description.
 - g. Shop Drawings.
 - h. Design Criteria.
2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Structural Supports.
 - c. Pipe Hangers and Supports.
 - d. Beam Clamps.
 - e. Concrete Inserts.
 - f. Equipment Stands.
 - g. Corrosive Atmosphere Coatings.
3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Hanger and Support Spacing.
 - c. Riser Clamps.

1.02 RELATED WORK

- A Division 3 - Concrete.
B Section 21 10 00 - Water-Based Fire-Suppression System.

1.03 REFERENCE

- A Applicable provisions of Division 1 shall govern work under this section.

1.04 REFERENCE STANDARDS

- A MSS SP-58.
B NFPA 13 Installation of Sprinkler Systems (Latest prevailing edition).
C NFPA 14 Installation of Standpipe and Hose Systems (Latest prevailing edition).
D NFPA 20 Installation of centrifugal fire pumps (Latest prevailing edition).
E UL Underwriters' Laboratories Listed.
F FM Factory Mutual Approved.

1.05 QUALITY ASSURANCE

- A Substitution of Materials Refer to Section 01 60 00 - Product Requirements.

1.06 DESCRIPTION

- A Provide all supporting devices as required for the installation of fire suppression equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for building piping.
- B Do not hang any fire suppression system item directly from a metal deck or run piping so it rests on the bottom chord of any truss or joist.
- C Fasteners depending on soft lead for holding power or requiring explosive powder actuation will not be accepted.
- D Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.

1.07 SHOP DRAWINGS

- A Refer to section 01 30 00 – Administrative Requirements, for submittal procedures.
- B Schedule all hanger and support devices indicating attachment method and type of device for each pipe size and type of service. Provide details on the working drawings submitted for approval with all pertinent information listed.

1.08 DESIGN CRITERIA

- A Materials and application of pipe hangers and supports shall be in accordance with MSS SP-58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application and Installation unless noted otherwise.
- B Materials and application of pipe hangers and supports shall be in accordance with NFPA rulings and be UL/FM listed and approved.
- C Piping connected to pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A B-Line; TOLCO: www.bline.com.
- B Anvil: www.anvilintl.com.
- C Erico: www.erico.com.
- D Afcon: www.afcon.org.
- E Roof Products & Systems: www.rpscubs.com.

2.02 STRUCTURAL SUPPORTS

- A Provide all supporting steel required for the installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the drawings.

2.03 PIPE HANGERS AND SUPPORTS

- A Hangers for Pipe Sizes 1/2" through 4":
 1. Carbon steel, adjustable swivel ring with 3/8" min. UL/FM approved hanger rods. B-Line B3170NF, Anvil 69 or 70.
 2. Carbon steel, adjustable clevis, standard, with UL/FM approved size hanger rods. B-Line B3100, Anvil 260.

- B Hangers for Pipe Sizes 4" Through 8":
 - 1. Carbon steel adjustable swivel ring with 1/2" min. UL/FM approved hanger rods. B-Line B3170NF, Anvil 69 or 70.
 - 2. Carbon steel, adjustable clevis, standard with UL/FM approved size hanger rods. B-Line B3100, Anvil 260.
- C Hangers For Pipe Sizes 10" and Up:
 - 1. Carbon steel, adjustable clevis, standard with UL/FM approved size hanger rods. B-Line B3100, Anvil 260.
- D Multiple or Trapeze Hangers:
 - 1. Manufactured steel channel system with manufacturers slotted interlocking pipe clamps with screw/nut securing and threaded hanger rods or steel channels with welded spacers and threaded hanger rods.
- E Wall Support:
 - 1. Carbon steel welded bracket with hanger. B-Line 3060 Series, Anvil 190 Series.
 - 2. Steel channels with pipe clamps.
- F Vertical Support:
 - 1. Carbon steel riser clamp. B-Line B3373, Anvil 261 for above floor use.
- G Floor Support:
 - 1. Carbon steel pipe saddle, stand and bolted floor flange. B-Line B3088T/B3093.
- H Copper Pipe Supports:
 - 1. All supports, fasteners, clamps, etc. directly connected to copper piping shall be copper plated or polyvinylchloride coated. Where steel channels are used, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Grinnell PS 1400 series.
- I Pipe Hanger Rods:
 - 1. Steel Hanger Rods:
 - a. Threaded both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
 - b. Size rods for individual hangers and trapeze support as indicated in the following schedule.

<u>Pipe Size</u>	<u>Diam. Of Rod</u>
Up to and Including 4"	3/8" or 9.5mm min.
5", 6" and 8"	1/2" or 12.7mm min.
10" and 12"	5/8" or 15.9mm min.

2.04 BEAM CLAMPS

- A MSS SP-58 Types 19 & 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick with a retaining ring and threaded rod of 3/8, 1/2, and 5/8 inch diameter. Furnish with a hardened steel cup point set screw. B-Line B3036L/B3034, Anvil 86/92.
- B MSS SP-58 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter. B-Line B3054, Anvil 228.

2.05 CONCRETE INSERTS

A Drilled Fasteners:

1. Concrete Construction:

- a. Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor.
- b. Manufacturers:
 - 1) Hilti: www.hilti.com.
 - 2) Rawl: www.rawl.com.
 - 3) Redhead: www.ramset-redhead.com.

2. Wood Construction:

- a. Side or bottom mount lag thread by rod thread one piece hanger attachment installed per the Manufacturers standard and carrying capacity limit.
- b. Manufacturers:
 - 1) Powers Fastener; Vertigo: www.powers.com.
 - 2) Erico; Hangermate: www.erico.com.

2.06 EQUIPMENT STANDS

- A Use structural steel members welded to and supported by pipe supports. Clean, prime and coat with three coat rust inhibiting alkyd paint or one coat epoxy mastic. Where exposed to weather, treat with corrosive atmosphere coatings.

2.07 CORROSIVE ATMOSPHERE COATINGS

- A Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication, ASTM A123, 1.5 ounces/square foot of surface each side. Mechanical galvanize threaded products, ASTM B695 Class 50, 2.0 mil coating. Field cuts and damaged finishes to be field covered with zinc rich paint of comparable thickness to factory coating.
- B Corrosive atmospheres include the following locations:
1. Food service/kitchen areas.

PART 3 EXECUTION

3.01 INSTALLATION

- A Size, apply and install supports and anchors in compliance with manufacturers recommendations.
- B Install supports to provide for free expansion of the piping system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.
- C Coordinate hanger and support installation to properly group piping of all trades.
- D Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes or continuous insert channels for the supporting steel. Where continuous insert channels are used, pipe supporting devices made specifically for use with the channels may be substituted for the specified supporting devices provided that similar types are used, and all data is submitted for prior approval.
- E Perform welding in accordance with standards of the American Welding Society.

3.02 HANGER AND SUPPORT SPACING

- A Use hangers with minimum vertical adjustment.
- B Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.
- C Support riser piping independently of connected horizontal piping.

- D Adjust hangers to obtain the slope specified in the piping section of these specifications.
- E Space hangers for pipe as follows:

<u>Pipe Material</u>	<u>Pipe Size</u>	<u>Max. Horiz. Spacing</u>	<u>Max. Vert. Spacing</u>
Steel	1" through 1-1/4"	12'-0"	15'-0"
Steel	1-1/2" through 8"	15'-0"	15'-0"
CPVC	1" through 1-1/4"	6'-0"	10'-0"
CPVC	1-1/2"	7'-0"	10'-0"
CPVC	2"	8'-0"	10'-0"
CPVC	2-1/2"	9'-0"	10'-0"
CPVC	3"	10'-0"	10'-0"

- F Hangers, supports and hanger spacing for CPVC plastic piping systems shall conform to the requirements of NFPA 13 and the manufacturer's requirements. Contractor shall provide details on the installation drawings for all proposed means of support.
- G Restraint hangers shall be installed at all sprinkler head location within 1'-0" for a single restraint and within 5'-0" for two points of restraint. The requirements for hanger restraint for systems in excess of 100 PSI pressure shall be followed.
- H Hangers for CPVC systems shall not compress, distort, cut or abrade the piping and shall allow free movement of the pipe to permit thermal expansion and contraction.
Unsupported length from the last hanger and an end sprinkler for steel piping systems shall be as follows:
 - 1" piping Not greater than 36"
 - 1-1/4" piping Not greater than 48"
 - 1-1/2" piping Not greater than 60"
or larger.

3.03 RISER CLAMPS

- A Support vertical piping with clamps secured to the piping and resting on the building structure or secured to the building structure below at each floor. Use method of securing the vertical risers to the building structure below in stairwell locations.

END OF SECTION 21 05 29

INTENTIONALLY LEFT BLANK

SECTION 21 10 00
WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A This section contains specifications for fire suppression pipe and pipe fittings for this project. Included are the following topics:

1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - i. Welder Qualifications.
2. PART 2 – PRODUCTS.
 - a. Fire Suppression Piping.
 - b. Unions and Flanges.
 - c. Mechanical Grooved Pipe Connections.
 - d. Sprinkler Heads.
 - e. Flexible Sprinkler Drop Fittings
 - f. Flow Switches.
 - g. Pressure Switches.
 - h. Local Alarm.
 - i. Pressure Gauges.
 - j. Valves.
 - k. Hose Outlet Valves.
 - l. Fire Department Connection.
3. PART 3 – EXECUTION.
 - a. General.
 - b. Preparation.
 - c. Erection.
 - d. Copper Pipe Joints.
 - e. Welded Pipe Joints.
 - f. Threaded Pipe Joints.
 - g. Mechanical Grooved Pipe Connections.
 - h. Unions and Flanges.
 - i. Flexible Sprinkler Drop Fittings.
 - j. Piping System Leak Tests.
 - k. Underground Water Main Flushing
 - l. Installation.

1.02 R

1.03 ELATED WORK

- A Section 21 05 00 - Common Work Results for Fire Suppression.
- B Section 21 05 29 - Hangers and Supports for Fire-Suppression Piping and Equipment.

1.04 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.05 REFERENCE STANDARDS

- A ANSI A21.4.
- B ANSI A21.11.
- C ANSI A21.51.
- D ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
- E ANSI B16.3 Malleable and Ductile Iron Threaded Fittings.
- F ANSI B16.4 Cast Iron Threaded Fittings.
- G ANSI B16.5 Pipe Flanges and Flanged Fittings.
- H ANSI B16.9 Factory Made Wrought Steel Buttweld Fittings.
- I ANSI B16.11 Forged Steel Fittings, Socket Welded and Threaded.
- J ANSI B16.18 Cast Bronze Solder Joint Pressure Fittings.
- K ANSI B16.22 Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
- L ANSI B16.29 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- M ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- N ASTM A105 Forgings, Carbon Steel, for Piping Components.
- O ASTM A126 Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
- P ASTM A135 Electric Resistance Welded Steel Pipe.
- Q ASTM A181 Forgings, Carbon Steel for General Purpose Piping.
- R ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- S ASTM A536 Ductile Iron Castings.
- T ASTM A795 Black and Hot Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
- U ASTM B88 Seamless Copper Water Tube.
- V AWS A5.8 Brazing Filler Metal.
- W AWS D10.9 Qualification of Welding Procedures and Welders for Piping and Tubing, Level AR3.
- X NFPA 13 Installation of Sprinkler Systems. (Latest prevailing edition).
- Y NFPA 14 Installation of Standpipe and Hose Systems. (Latest prevailing edition).
- Z UL Underwriters' Laboratories Listing.
- AA FM Factory Mutual Approval.

1.06 SHOP DRAWINGS

- A Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B Schedule from the Contractor indicating the ANSI/ASTM specification number of the pipe being proposed along with its type and grade, if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.

1.07 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.

- B Order all copper and steel pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.
- C Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.08 DELIVERY, STORAGE, AND HANDLING

- A Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D Storage and protection methods must allow inspection to verify products.

1.09 DESIGN CRITERIA

- A Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.
- B Construct all piping systems for the highest pressures and temperatures in the respective system but not less than 175 psig.
- C Where weld fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- D Where mechanical grooved fittings are used, use only ASTM standard radius fittings, short radius grooved fittings is not allowed.
- E Where ASTM A53 or A795 type F pipe is specified, grade A type E or S, or grade B type E or S may be substituted at Contractor's option. Where ASTM A135 grade A pipe is specified, grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- F Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper copper tubing may be substituted at Contractor's option.

1.10 WELDER QUALIFICATIONS

- A Welding procedures, welders, and welding operators for all building service piping to be in accordance with certified welding procedures of the National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing. Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.
- B The Engineer reserves the right to test the work of any welder employed on the project, at the Owner's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project and all defective welds replaced.

PART 2 PRODUCTS

2.01 FIRE SUPPRESSION PIPING

- A Steel Pipe:
 - 1. Black steel pipe welded and seamless, Type F, Grade A, ASTM A53; black welded and seamless steel pipe for fire protection use, Type F, ASTM A795; electric resistance welded steel pipe, Grade A, ASTM A135.

2. Pipe wall Thickness:
 - a. Threaded pipe shall have a minimum wall thickness of schedule 40.
 - b. All other pipe shall have a minimum wall thickness of schedule 10.
 - c. Piping 2" and under shall be minimum schedule 40 unless stated otherwise herein.
3. Fittings: Cast iron threaded fittings, Class 125 or 250, ASTM A126/ANSI B16.4. Malleable and ductile iron threaded fittings, Class 150 or 300, ASTM A197/ANSI B16.3. Standard weight seamless carbon steel weld fittings, ASTM A234 grade, ANSI B16.9. Mechanical grooved fittings with EPDM gaskets, ASTM A536 ductile iron, ASTM A47 malleable iron or ASTM A53 fabricated steel. For wet pipe systems mechanical tee fittings with full iron back equal to Grinnell Figure 730 will be allowed only as needed for connection to existing systems. Outlets for drypipe and pre-action systems shall be mechanical tees. Mechanical tees with U-bolt back or other fastening means are not allowed.
4. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.
5. Finish: Hot dipped zinc coated (galvanized) finish on piping and fittings shall be used in drypipe and pre-action systems, piping exposed to weather and piping exposed to corrosive environments where indicated. Thread or cut groove hot dipped zinc coated pipe ends for fitting connections. Indoor dry standpipe systems supplied by a Fire Dept. connection only may be black steel piping and fittings.

B CPVC PIPE:

1. CPVC piping is allowed for branch pipe only when allowed to be installed per NFPA 13.
2. CPVC Sprinkler Pipe, ASTM F 442, SDR 13.5.
3. CPVC Sprinkler Fittings, Schedule 40 and Schedule 80 dimensions for 3/4" through 1-1/4", Schedule 80 for 1-1/2" through 2". Products to be UL Listed/FM Approved for a rated working pressure of 175 psi at 150°F for sprinkler service. Spears FlameGuard or Harvel BlazeMaster.

2.02 UNIONS AND FLANGES

A 2" and Smaller Steel:

1. ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Grooved couplings may be used in lieu of unions.

B 2" and Smaller Copper:

1. ANSI B16.18 cast bronze union coupling or ANSI B15.24 Class 150 cast bronze flanges.

C 2-1/2" and Larger:

1. ASTM A181 or A105, Class 150, grade 1 hot forged steel flanges of threaded, welding neck, or slip-on pattern on black steel and threaded only on galvanized steel. ANSI B16.1 or ANSI B16.5, Class 150 cast iron threaded flanges. Use raised face flanges ANSI B16.5 for mating with other raised face flanges or equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

D 2-1/2" and Larger Copper:

1. ANSI B16.24, Class 150 cast bronze flanges with raised face.

2.03 MECHANICAL GROOVED PIPE CONNECTIONS

- A Mechanical grooved pipe couplings and fittings, ASTM F1476, as manufactured by Victaulic, Anvil or Grinnell may be used with steel pipe. Mechanical grooved components and assemblies to be rated for minimum 175 psi working pressure unless noted otherwise.**

- B All mechanical grooved pipe material including gaskets, couplings, fittings and flange adapters shall be from the same manufacturer.
- C Couplings and fittings to be malleable iron, ASTM A47, or ductile iron A536 with painted finish. Fittings used on galvanized steel pipe to have galvanized finish, ASTM A153.
- D Gaskets to be EPDM, ASTM D2000. Gaskets for dry systems to be flush seal design. Heat treated carbon steel oval neck track bolts and nuts, ASTM A-183, with zinc electroplated finish.
- E Flange adapters to be ductile iron, ASTM A536; except at lug type butterfly valves where standard threaded flanges shall be used.
- F Credit for the inherent flexibility of mechanical grooved pipe connections when used for expansion joints or flexible connectors may be allowed upon specific application by the Contractor. Three flexible couplings at first three connection points both upstream and downstream of pumps may be used in lieu of flexible connectors. Request for expansion joints shall be made in writing and shall include service, location, line size, proposed application and supporting calculations for the intended service.

2.04 SPRINKLER HEADS

- A Manufacturer: Sprinkler head model numbers establish type and style of head. Products of the following manufacturers determined to be equal by the Engineer will be accepted:
 - 1. Tyco: www.tycofire.com.
 - 2. Reliable: www.reliablesprinkler.com.
 - 3. Victaulic: www.victaulic.com.
 - 4. Viking: www.vikingfire.com.
- B Standard coverage sprinkler heads are to be the basis for design unless noted otherwise on the plans or within these specifications.
- C Fusible link or glass bulb type, cast brass or bronze construction. Provide heads with nominal 1/2" or 17/32" discharge orifice except where greater than normal density requires large orifice.
- D Select fusible link or glass bulb temperature rating to not exceed maximum ambient temperature rating allowed under normal conditions at installed location. Provide ordinary temperature (155 to 165 degree) fusible link or glass bulb type except at skylights, sealed display windows, unventilated attics and roof spaces, over cooking equipment, adjacent to diffusers, unit heaters, uninsulated heating pipes or ducts, mechanical rooms, storage rooms, or where otherwise indicated.
- E Provide quantity of spare heads as noted below and 1 wrench for each type of head and each temperature range installed. Provide 6 spare heads per 300 or less installed heads, 12 per 1000 or less and 24 for more than 1000. Provide steel cabinet for storage of heads and wrenches. Provide an equal number of concealed cover plates and/or sprinkler escutcheons for each spare sprinkler head.
 - 1. Quick Response Upright: Viking Microfast M (QR), brass finish.
 - 2. Quick Response Pendant: Viking Microfast M, chrome plated finish and escutcheon.
 - 3. Quick Response Sidewall: Viking Microfast M, chrome plated finish and escutcheon.
 - 4. Dry Horizontal Sidewall (Self-contained type): Viking Model M (Quick response), adjustable, recessed, with chrome escutcheon.
 - 5. Concealed sprinkler: Viking Mirage (Quick Response), with adjustable concealed cover plate. Cover plate finish to be selected by the Engineer from the manufacturer's standard finish selections.

2.05 FLEXIBLE SPRINKLER DROP FITTINGS

- A Manufacturers: FlexHead Industries, Victaulic or Viking.

- B Corrugated Type 304 stainless steel hose with braided Type 304 stainless steel exterior cover, welded stainless steel or zinc plated steel inlet and outlet threaded fittings with EPDM seals. 175 PSI pressure rating. 225 °F temperature rating, 1" minimum internal hose diameter. 40" maximum hose length, straight or angle outlet configuration. Galvanized steel ceiling support bar and brackets selected to match project ceiling support system requirements. UL Listed and FM approved.

2.06 FLOW SWITCHES

- A Vane type waterflow switch with metal enclosure, adjustable pneumatic retard and electrical characteristics compatible with alarm system.

2.07 PRESSURE SWITCHES

- A Pressure actuated switch with field adjustable settings, metal enclosure and electrical characteristics compatible with alarm system.

2.08 LOCAL ALARM

- A Weatherproof electric horn/strobe with red painted metal housing, mounting base and weatherproof gasket seal, and electrical characteristics compatible with alarm system. The horn strobe should be mounted above or as close as possible to the fire department connection.

2.09 PRESSURE GAUGES

- A Manufacturer:
 1. Ametek/U. S. Gauge Division: www.ametekusg.com.
 2. Ashcroft: www.ashcroft.com.
 3. Marsh: www.marshalinstruments.com.
 4. Taylor: www.taylorusa.com.
 5. H. O. Trerice: www.trerice.com.
 6. Weiss: www.weissinstruments.com.
 7. Weksler: www.weksler-gauges.com.
- B Cast aluminum, stainless steel, brass, polycarbonate or ABS case of not less than 3.5 inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from the front of the dial, 99% accuracy over the middle half of the scale, 98.5% accuracy over the remainder of the scale. Include bronze 3-way globe valve with plugged outlet for Fire Inspector's test gauge.

2.10 VALVES

- A Manufacturers:
 1. Kennedy: www.kennedyvalve.com.
 2. Milwaukee: www.milwaukeevalve.com.
 3. Nibco: www.nibco.com.
 4. Stockham: www.stockham.com.
 5. Victaulic: www.victaulic.com.
 6. Watts: www.watts.com.
- B Ball Valves:
 1. 2" and smaller: Bronze, 2-piece, threaded or sweat ends, standard port, blowout proof stem, chrome plated ball, glass reinforced seats, UL approved @ 250 psi. Watts No. B-6000 UL.
- C Gate Valves:
 1. 2" and smaller: Outside screw and yoke gate valves, 175 psig, bronze body, bronze mounted, screwed bonnet, rising stem, solid wedge, with normally open tamper switch with double wire leads.

2. 2-1/2" and larger: Outside screw and yoke gate valves, 175 psig, cast iron body, bronze mounted, bolted bonnet, rising stem, solid wedge, with normally open tamper switch with double wire leads.
- D Butterfly Valves:
1. 2" and smaller: Bronze body butterfly valve, 175 psig, geared operator, visible position indicator, normally open tamper switch with double wire leads, Buna or Viton seat, stainless steel disc and stem.
 2. 2" and larger: Cast or ductile iron body butterfly valve, lug style or grooved, 175 psig, geared operator, visible position indicator, normally open tamper switch with double wire leads, EPDM resilient seat, EPDM seals, nickel plated ductile iron disc. Valve assembly to be bubble tight to 175 psig with no downstream flange/pipe attached. Use cap screws for removal of downstream piping while using the valve for system shutoff.
- E Supervisory/Tamper Switches:
1. For O S & Y valve or butterfly valve installations, UL/FM listed/approved, to monitor position of valve, tamper resistant cover screws, single or double SPDT switch contacts, corrosion resistant, for indoor or outdoor use, NEMA 4 & 6P enclosures.
- F Check Valves:
1. 3" and smaller: Bronze body, threaded end, Y-pattern, regrindable bronze seat, renewable bronze disc, 175 psig, suitable for installation in a horizontal or vertical line with flow upward.
 2. 2-1/2" and larger: Cast or ductile iron body, flanged or grooved ends, bronze trim, bolted cap, renewable bronze seat and disc, 175 psig, suitable for installation in a horizontal or vertical line with flow upward.
 3. Provide 1/2" automatic drip drain on inlet of fire dept. connection check valve.
- G Spring Loaded Check Valves:
1. 2" and smaller: Bronze body, threaded ends, bronze trim, stainless steel spring, stainless steel center guide pin, 175 psig, teflon seat unless only bronze available.
 2. 2-1/2" and larger: Cast or ductile iron body, wafer or globe type, bronze trim, bronze or EPDM seat, stainless steel spring, stainless steel stem if stem is required, 175 psig.
- H Drain Valves:
1. 3/4" minimum two piece bronze body ball valve; threaded ends, chrome plated bronze ball; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 400 psig WOG, with hose thread outlet and cap.
- I Double Check Valves:
1. Manufacturers:
 - a. Ames: www.ames.com.
 - b. Conbraco: www.conbraco.com.
 - c. Febco: www.febcoonline.com.
 - d. Watts: www.watts.com.
 - e. Wilkins: www.wilkins.com.
 2. ASSE 1015 double check backflow preventer with 2 independent spring loaded check valves, 2 isolation ball or gate valves with normally open tamper switch with double wire leads, 4 valve test ports. Constructed of bronze or epoxy coated cast iron or stainless steel body with bronze and plastic internal parts, stainless steel springs, silicone rubber valve discs, bronze seats, rated for 175 psig.

2.11 HOSE OUTLET VALVES

- A Manufacturer:
 - 1. Badger-Powhatan: www.badgerfire.com.
 - 2. Croker: www.croker.com.
 - 3. Elkhart Brass: www.elkhartbrass.com.
 - 4. Potter-Roemer: www.potterroemer.com.
 - 5. Guardian: www.guardian.com.
- B Class I and Class III Systems:
 - 1. 2-1/2" brass angle valve, 300 psig, with removable red handwheel, 2-1/2"x1-1/2" reducing lug pin connector coupling and National Standard male hose thread outlet, cap and chain. Provide N.P.T. female outlet where hose is required.

2.12 FIRE DEPARTMENT CONNECTION

- A Manufacturer:
 - 1. Badger-Powhatan: www.badgerfire.com.
 - 2. Croker: www.croker.com.
 - 3. Elkhart Brass: www.elkhartbrass.com.
 - 4. J.W. Moon: www.wilcosupplyinc.com.
 - 5. Potter-Roemer: www.potterroemer.com.
 - 6. W.D. Allen: www.wdallen.com.
- B Exposed:
 - 1. Forged aluminum exposed fire department inlet, 5"x4" Storz inlet body, and cap with chain, locking inlet, cast brass lettered identification backplate.

PART 3 EXECUTION

3.01 GENERAL

- A Install pipe fittings, and other fire suppression system components in accordance with reference standards, manufacturer recommendations and recognized industry practices.

3.02 PREPARATION

- A Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.03 ERECTION

- A Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of fire protection piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, ceiling grid layout, light fixtures and grilles before installing piping.
- B Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.
- C Provide 3/32" min. thickness steel nailing plates behind or on either side of piping where the possibility of penetration from nails or drywall screws exists.
- D Maintain piping in clean condition internally during construction.
- E Provide clearance for access to valves and piping specialties.
- F Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.

- G Install piping so that system can be drained. Where possible, slope to main drain valve. Slope dry pipe and pre-action systems subject to freezing at minimum 1/4"/10' on mains and 1/2"/10' on branches. Where piping not susceptible to freezing cannot be fully drained, install nipple and cap for drainage of less than 5 gallons or ball valve with hose thread outlet and cap for drainage over 5 gallons. Pipe main drain valve to grade or to air gap sewer receptor.
- H Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.
- I Do not route piping within exterior walls.
- J Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.
- K Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to all equipment, fixtures and systems installed by others where same requires the piping services indicated in this section.

3.04 COPPER PIPE JOINTS

- A Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with metal brush, emery cloth or sandpaper. Remove residue from the cleaning operation and assemble joint to socket stop. Apply flame to fitting until brazing alloy melts when placed at joint. Wipe excess alloy from joint.

3.05 WELDED PIPE JOINTS

- A Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable. "Weldolets" and "Threadolets" may be used up to following sizes:

Maximum	
Weldolet/ Threadolet Pipe Diameter	Main Diameter
3/4"	1-1/4"
1"	1-1/2"
1-1/4"	2"
1-1/2"	2-1/2"
2"	3"
3"	4"
4"	6"
6"	8"

3.06 THREADED PIPE JOINTS

- A Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.07 MECHANICAL GROOVED PIPE CONNECTIONS

- A Use pipe factory grooved in accordance with the coupling manufacturer's specifications or field grooved pipe in accordance with the same specifications using specially designed tools available for the application. Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with the coupling manufacturer's specifications.

3.08 UNIONS AND FLANGES

- A Install a union, flange or grooved coupling combination at each connection to each piece of equipment and at other items which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union or grooved coupling combination

connections on the equipment side of the valve. Concealed unions, flanges or couplings are not acceptable.

3.09 FLEXIBLE SPRINKLER DROP FITTINGS

- A Install in accordance with manufacturer's installation instructions following minimum bend radii, maximum number of bends and bend distance from end requirements.

3.10 PIPING SYSTEM LEAK TESTS

- A Conduct pressure test with test medium of water. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.
- B Test piping in sections or entire system as required by sequence of construction. Do not conceal pipe until it has been successfully tested. If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Entire test must be witnessed by the Owner's representative.
- C Use clean water and remove air from the piping being tested where possible. Measure and record test pressure at the high point in the system.
- D Test system at 200 psi for 2 hours showing no leakage. Where system design is in excess of 150 psig, test at a pressure 50 psig above system design pressure.
- E All pressure tests are to be documented on NFPA Contractor's Material and Test Certificate forms.

3.11 UNDERGROUND WATER MAIN FLUSHING

- A Conduct flushing of the underground water/fire main service as required by NFPA 13. The 200 PSI pressure test of the main shall be conducted by the installer of the main. The flushing operation is to be documented on NFPA Underground Contractor's Material and Test Certificate forms.

3.12 INSTALLATION

- A Install fire protection system components in accordance with NFPA rulings, listings and manufacturers recommendations. Locate where accessible for servicing and replacement.
- B Sprinkler Heads: Locate sprinkler heads as indicated on fire protection plan and reflected ceiling plan maintaining minimum clearances from obstructions, ceilings and walls. Install sprinkler heads level in locations not subject to spray pattern interference. Provide fire sprinkler head installations below ductwork, soffits, etc.
- C Switches: Locate flow and pressure switches where indicated and where required to obtain specified zoning to isolate floors and major areas of floors. Provide valve test connection for flow switch adjacent to flow switch. Pipe to floor drain. Test flow switch to verify proper operation.
- D Gauges: Provide a valve pressure gauge in main fire protection riser, at the top of each piping riser, at inlet and outlet of pump and elsewhere as indicated.
- E Valves: Properly align piping before installation of valves. Do not support weight of piping system on valve ends. Mount valves in locations which allow access for operation, servicing and replacement. Install all valves with the stem in the upright or horizontal position. Valves installed with the stems down will not be accepted. Provide a riser shutoff valve and a capped hose thread drain valve at the bottom of each riser. Provide capped hose thread drain valves to allow draining of each portion of piping.
- F Hose Outlet Valves: Install at each standpipe outlet and elsewhere where indicated approximately 4 feet above floor.
- G Fire Department: Mount on wall where indicated. Support from structure independent of piping. Locate between 2' to 3' above grade. Fill wall penetration with insulation and caulk exterior and interior face of wall opening weather tight.

END OF SECTION 21 10 00

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 SCOPE

A This section includes information common to two or more technical plumbing specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

1. PART 1 – GENERAL.
 - a. Scope.
 - b. Reference.
 - c. Standards.
 - d. Lead Free Requirements
 - e. Quality Assurance.
 - f. Continuity of Existing Services.
 - g. Protection of Finished Surfaces.
 - h. Sleeves and Openings.
 - i. Sealing and Firestopping.
 - j. Off Site Storage.
 - k. Codes.
 - l. Request and Certification for Payment.
 - m. Certificates and Inspections.
 - n. Submittals.
 - o. Operating and Maintenance Data.
 - p. Training Of Owner Personnel.
 - q. Record Drawings.
2. PART 2 – PRODUCTS.
 - a. Access Panels and Doors.
 - b. Identification.
 - c. Bedding and Backfill.
 - d. Sealing and Firestopping.
3. PART 3 – EXECUTION.
 - a. Demolition.
 - b. Excavation and Backfill.
 - c. Sheeting, Shoring and Bracing.
 - d. Concrete Work.
 - e. Cutting and Patching.
 - f. Building Access.
 - g. Equipment Access.
 - h. Coordination.
 - i. Identification.
 - j. Lubrication.
 - k. Sleeves.

- I. Sealing and Firestopping.
- m. Owner Training.

1.02 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.
- B This section applies to all Division 22 sections of plumbing.

1.03 STANDARDS

- A Abbreviations of standards organizations referenced in this, and other sections are as follows:
 - 1. ABMA American Boiler Manufacturers Association.
 - 2. ACPA American Concrete Pipe Association.
 - 3. AGA American Gas Association.
 - 4. AMCA Air Movement and Control Association.
 - 5. ANSI American National Standards Institute.
 - 6. AHRI Air-Conditioning, Heating and Refrigeration Institute.
 - 7. ASME American Society of Mechanical Engineers.
 - 8. ASPE American Society of Plumbing Engineers.
 - 9. ASSE American Society of Sanitary Engineering.
 - 10. ASTM American Society for Testing and Materials.
 - 11. AWWA American Water Works Association.
 - 12. AWS American Welding Society.
 - 13. CISPI Cast Iron Soil Pipe Institute.
 - 14. CGA Compressed Gas Association.
 - 15. CS Commercial Standards, Products Standards Sections, Office of Eng. Standards Service, NBS.
 - 16. EPA Environmental Protection Agency.
 - 17. FS Federal Specifications, Superintendent of Documents, U.S. Government Printing Office.
 - 18. GAMA Gas Appliance Manufacturers Association.
 - 19. IAPMO International Association of Plumbing & Mechanical Officials.
 - 20. IEEE Institute of Electrical and Electronics Engineers.
 - 21. ISA Instrument Society of America.
 - 22. MCA Mechanical Contractors Association.
 - 23. MICA Midwest Insulation Contractors Association.
 - 24. MSS Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
 - 25. NBS National Bureau of Standards.
 - 26. NEC National Electric Code.
 - 27. NEMA National Electrical Manufacturers Association.
 - 28. NFPA National Fire Protection Association.
 - 29. NSF National Sanitation Foundation.
 - 30. PDI Plumbing and Drainage Institute.
 - 31. SMACNA Sheet Metal and Air Conditioning Contractors' National Association. Inc.
 - 32. STI Steel Tank Institute.

33. UL Underwriters Laboratories Inc.
- B Standards referenced in this section:
1. ACI 614 Recommended Practice for Measuring, Mixing and Placing of Concrete.
 2. ASTM D1557 Standard Test Method for Moisture-Density Relations of Soils.
 3. ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 4. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 5. D.O.T. Standard Specifications for Road and Bridge Construction, State of Wisconsin Dept. of Transportation.
 6. UL1479 Fire Tests of Through-Penetration Firestops.
 7. UL723 Surface Burning Characteristics of Building Materials.

1.04 LEAD FREE REQUIREMENTS

- A All materials that contact potable water shall be lead free. Lead free refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per the Federal Safe Drinking Water Act as amended January 4, 2011, Section 1417.
- B This requirement applies to all of the subsequent Plumbing Specification Sections and Plumbing Drawings and supersedes any part or model number that may conflict with this requirement.

1.05 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B All products and materials used are to be new, undamaged, clean and in good condition. Existing products and materials are not to be reused unless specifically indicated.
- C Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the intended performance from the system into which these items are placed.

1.06 CONTINUITY OF EXISTING SERVICES

- A Do not interrupt or change existing services without prior written approval from the Owner's Project Representative. When interruption is required, coordinate scheduling of down-time with the Owner to minimize disruption to his activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

1.07 PROTECTION OF FINISHED SURFACES

- A Refer to Division 1, General Requirements for Protection of Finished Surfaces.

1.08 SLEEVES AND OPENINGS

- A Refer to Division 1, General Requirements for Sleeves and Openings.

1.09 SEALING AND FIRESTOPPING

- A Sealing and firestopping of sleeves/openings between piping, etc. and the sleeve or structural opening shall be the responsibility of the Contractor whose work penetrates the opening. The Contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.

1.10 OFF SITE STORAGE

- A Prior approval by Owner and the Engineer will be needed. The Contractor shall submit Storage Agreement Form AD-BDC-74 to Owner for consideration of offsite materials storage. Generally, sleeves, pipe/pipe fittings and similar rough-in material will not be accepted for offsite storage. No material will be accepted for offsite storage unless shop drawings for the material have been approved.

1.11 CODES

A Comply with requirements of Wisconsin Code.

1.12 REQUEST AND CERTIFICATION FOR PAYMENT

A Refer to the General Conditions for Request and Certification for Payment.

1.13 CERTIFICATES AND INSPECTIONS

A Refer also to the General Conditions for Permits, Regulations, Utilities and Taxes.

1.14 SUBMITTALS

A Refer to section 01 30 00 - Administrative Requirements, for submittal procedures.

B Not more than two weeks after award of contract but before any shop drawings are submitted, Contractor to submit the following plumbing system data sheet. List piping material type for each piping service on the project, ASTM number, schedule or pressure class, joint type, manufacturer and model number where appropriate. List valves and specialties for each piping service, fixture and equipment with manufacturer and model number. The approved plumbing system data sheet(s) will be made available to the Owner's Project Representative for their use on this project.

PLUMBING SYSTEM DATA SHEET

<u>Item</u>	<u>Pipe Service/Sizes</u>	<u>Manufacturer/Model No.</u>	<u>Remarks</u>
-------------	---------------------------	-------------------------------	----------------

Pipe

Fittings

Unions

Valves:

Ball

Butterfly

Balancing

Check

Other

Pipe Specialties:

Thermometers

Press Gauges

Strainers

Building Penetrations

Hangers & Supports

Insulation

Plbg. Specialties:

Floor Drains

Cleanouts

Water Hammer Arrestors

Backflow Preventers

Wall/Yard Hydrants

Hose Bibbs

Trap Primers

Wash Machine Boxes

Plbg. Fixtures

Plbg. Equipment

- C Shop drawing submittals are to be bound, labeled, contain the project manual cover page and a material index list page showing item designation, manufacturer and additional items supplied with the installation. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Include wiring diagrams of electrically powered equipment.

1.15 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.
- B In addition to the general content specified under Section 01 78 00 - Closeout Submittals supply the following additional documentation:
 1. Records of tests performed to certify compliance with system requirements.
 2. Manufacturer's wiring diagrams for electrically powered equipment.
 3. Certificates of inspection by regulatory agencies.
 4. Valve schedules.
 5. Lubrication instructions, including list/frequency of lubrication.
 6. Parts list for fixtures, equipment, valves and specialties.
 7. Manufacturer's installation, operation and maintenance recommendations for fixtures, equipment, valves and specialties.
 8. Additional information as indicated in the technical specification sections.

1.16 TRAINING OF OWNER PERSONNEL

- A Instruct Owner's personnel in the proper operation and maintenance of systems and equipment provided as part of this project. Include not less than 2 hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup, operation and shutdown procedures for all equipment. All training to be during normal working hours. Videotape all instructions and provide Owner with copy.

1.17 RECORD DRAWINGS

- A Refer to Division 1, General Requirements for Record Drawings.

PART 2 PRODUCTS

2.01 ACCESS PANELS AND DOORS

- A Lay-in Ceilings:
 1. Removable lay-in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Division 09 are sufficient; no additional access provisions are required unless specifically indicated.
- B Plaster Walls and Ceilings:
 1. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers, and similar wet areas, concealed hinges, screwdriver operated cam latch for general applications, key lock for use in public or secured areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the item needing service; minimum size is 12" by 12".

2.02 IDENTIFICATION

- A STENCILS:
1. Not less than 1 inch high letters/numbers for marking pipe and equipment.
- B ENGRAVED NAME PLATES:
1. White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting.
 2. Manufacturers:
 - a. Setonply Style 2060 by Seton Name Plate Company: www.seton.com.
 - b. Emedolite Style EIP by EMED Co.: www.emedco.com.
 - c. Brimar Industries, Inc.: www.pipemarker.com.
 - d. Or equal by W. H. Brady: www.bradyid.com.
- C SNAP-AROUND PIPE MARKERS:
1. One-piece, preformed, vinyl construction, snap-around or strap-around pipe markers with applicable labeling and flow direction arrows, 3/4" min. size for lettering. Provide nylon ties on each end of pipe markers.
 2. Manufacturers:
 - a. Seton Setmark: www.seton.com.
- D VALVE TAGS:
1. Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains, brass "S" hooks or one piece nylon ties around the valve stem.
 2. Manufacturers:
 - a. EMED Co.: www.emedco.com.
 - b. Seton Name Plate Company: www.seton.com.
 - c. W. H. Brady: www.bradyid.com.
 - d. Brimar Industries, Inc.: www.pipemarker.com.

2.03 BEDDING AND BACKFILL

- A Bedding up to a point 12" inches above the top of the pipe shall be thoroughly compacted sand or crushed stone chips meeting the following gradations:

<u>Gradation for Bedding Sand</u>		<u>Gradation for Crushed Stone Chip Bedding</u>	
<u>Sieve Size</u>	<u>% Passing (by Wt)</u>	<u>Sieve Size</u>	<u>% Passing (by Wt)</u>
1 inch	100	1/2 inch	100
No. 16	45 - 80	No. 4	75 - 100
No. 200	2 - 10	No. 100	10 - 25

- B Backfill above the bedding in lawn areas shall be thoroughly compacted excavated material free of large stones, organic, perishable, and frozen materials.
- C Backfill above the bedding under existing and future utilities, paving, sidewalks, curbs, roads and buildings shall be granular materials, pit run sand, gravel, or crushed stone, free from large stones, organic, perishable, and frozen materials.

2.04 SEALING AND FIRESTOPPING

- A FIRE AND/OR SMOKE RATED PENETRATIONS:
1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Hilti: www.hilti.com.

- c. Rectorseal: www.rectorseal.com.
 - d. STI/SpecSeal: www.stifirestop.com.
 - e. Tremco: www.tremcosealants.com.
2. All firestopping systems shall be provided by the same manufacturer.
 3. Fire stop systems shall be UL listed or tested by an independent testing laboratory approved by the Department of Commerce.
 4. Submittals: Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgment can be based upon.
 5. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.
 6. Use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop blocks, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.
- B NON-RATED PENETRATIONS:**
1. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the cored opening or a water-stop type wall sleeve. The operating bolts of the mechanical type seal shall be accessible from the interior of the building.
 2. At pipe penetrations of non-rated interior partitions, floors and exterior walls, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material.

PART 3 EXECUTION

3.01 DEMOLITION

- A** Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the Owner to minimize disruption to the existing building occupants.
- B** All pipe, fixtures, equipment, wiring and associated conduit, insulation and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor except as specifically noted otherwise. All designated equipment is to be turned over to the Owner for their use at a place and time so designated. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.

3.02 EXCAVATION AND BACKFILL

- A** Perform all excavation and backfill work necessary to accomplish indicated plumbing systems installation. Excavate to bottom of pipe and structure bedding, 4" in stable soils, 6" in rock or wet trenches and 8" in unstable soil. Finish bottoms of excavations to true, level surface.
- B** Tunnel or remove sidewalk and curb in areas of excavation to the nearest joint. Remove pavements, curbs and gutters to neat and straight lines to the limits of removal.

- C Make saw cut lines parallel to existing joints, or parallel or perpendicular to pavement edges to form a neat patch. Carefully remove remaining pavement within the saw cut area. Leave existing base materials between the area disturbed by the work and the saw cut line undisturbed by the saw cutting, pavement removal, or pavement replacement processes.
- D Strip topsoil from area to be excavated, free from subsoil and debris, and store for later re-spreading.
- E At no time place excavated materials where they will impede surface drainage unless such drainage is being safely rerouted away from the excavation.
- F Excavate whatever materials are encountered as required to place at the elevations shown, all pipe, manholes, and other work. Remove debris and rubbish from excavations before placing bedding and backfill material.
- G Remove surplus excavated materials from site.
- H Verify the locations of any water, drainage, gas, sewer, electric, telephone or steam lines which may be encountered in the excavation. Underpin and support all lines. Cut off service connections encountered which are to be removed at the limits of the excavation and cap.
- I Provide and maintain all fencing, barricades, signs, warning lights, and/or other equipment necessary to keep all excavation pits and trenches and the entire subgrade area safe under all circumstances and at all times. No excavation shall be left unattended without adequate protection.
- J Elevations shown on the plans are subject to such revisions as may be necessary to fit field conditions. No adjustment in compensation will be made for adjustments up to two (2) feet above or below the grades indicated on the plans.
- K Install lines passing under foundations with minimum of 1-1/2 inch clearance to concrete and ensure there is no disturbance of bearing soil.
- L Bed pipe up to a point 12" above the top of the pipe. Take care during bedding, compaction and backfill not to disturb or damage piping.
- M Mechanically compact bedding and backfill to prevent settlement. The initial compacted lift to not exceed 24" compacted to 95% density per Modified Proctor Test (ASTM D-1557). Subsequent lifts under pavements, curbs, walks and structures are not to exceed 12" and be compacted to 95% density per Modified Proctor Test. In all other areas where construction above the excavation is not anticipated within 2 years, mechanically compact backfill in lifts not exceeding 24" to 90% density per Modified Proctor Test. Route the equipment over each lift of the material so that the compaction equipment contacts all areas of the surface of the lift.

3.03 SHEETING, SHORING AND BRACING

- A Provide shoring, sheet piling and bracing in conformance with the Wisconsin Administrative Code to prevent earth from caving or washing into the excavation. Shore and underpin to properly support adjacent or adjoining structures. Abandon in place shoring, sheet piling and underpinning below the top of the pipe, or, if approved in advance by the engineer, maintained in place until other permanent support approved by the Engineer is provided.

3.04 CONCRETE WORK

- A Cast-in-place concrete within the building will be performed by the Division 3 Contractor unless otherwise noted. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support or installation of plumbing piping, fixtures, specialties and equipment. Coordinate locations of equipment, pipe penetrations in wet areas, etc. with the Division 3 Contractor.
- B Plumbing related cast-in-place concrete on the exterior of the building to be provided by this Contractor in conformance with requirements of Division 3.

- C This includes piping thrust restraints, pipe supports, hydrant supports, manholes, catch basins, grease traps, septic tanks, distribution boxes, valve pits, meter pits, cleanout cover pads, yard hydrant pads, etc.

3.05 CUTTING AND PATCHING

- A Refer to Division 1, General Requirements for Cutting and Patching.

3.06 BUILDING ACCESS

- A Arrange for the necessary openings in the building to allow for admittance or removal of all apparatus. When the building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.07 EQUIPMENT ACCESS

- A Install all piping, conduit and accessories to permit access to equipment for maintenance and service. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Access doors in general construction are to be furnished by the Plumbing Contractor and installed by the General Contractor.
- B Provide color coded thumb tacks or screws, depending on the surface, for use in accessible ceilings which do not require access panels.

3.08 COORDINATION

- A Coordinate all work with other Contractors prior to installation. Any work that is not coordinated and that interferes with other Contractor's work shall be removed or relocated at the installing Contractor's expense.
- B Verify that all devices are compatible for the type of construction and surfaces on which they will be used.

3.09 IDENTIFICATION

- A Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion.
- B Where stenciling is not appropriate for equipment identification, engraved name plates may be used.
- C Identify interior piping not less than once every 30 feet, not less than once in each room, adjacent to each access door or panel, and on both side of the partition where accessible piping passes through walls or floors. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a light background or white enamel against a dark background.
- D Identify all exterior buried piping for entire length with underground warning tape except for sewer piping which is routed in straight lines between manholes or cleanouts. Place tape 6"-12" below finished grade along entire length of pipe. Extend tape to surface at building entrances, meters, hydrants and valves. Where existing underground warning tape is broken during excavation, replace with new tape identifying appropriate service and securely spliced to ends of existing tape.
- E Identify valves with brass tags bearing a system identification and a valve sequence number. Valve tags are not required at a terminal device unless the valves are greater than ten feet from the device, located in another room or not visible from device. Provide a typewritten valve schedule and pipe identification schedule indicating the valve number and the equipment or areas supplied by each valve and the symbols used for pipe identification; locate schedules in mechanical room and in each Operating and Maintenance manual. Schedule in mechanical room to be framed under clear plastic.

3.10 LUBRICATION

- A Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason.

- B Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by the Owner. Maintain a log of all lubricants used and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

3.11 SLEEVES

- A Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Patch wall around sleeve to match adjacent wall construction and finish. Grout area around sleeve in masonry construction. In finished spaces where pipe penetration through wall is exposed to view, sheet metal sleeve shall be installed flush with face of wall. In existing poured concrete walls where penetration is core drilled, pipe sleeve is not required.
- B Pipe sleeves are not required in interior non-rated drywall, plaster or wood partitions and sleeves are not required in existing poured concrete walls where penetrations are core drilled.
- C Pipe sleeves in new poured concrete construction shall be schedule 40 steel pipe (sized to allow insulated pipe to run through sleeve), cast in place.
- D In all piping floor penetrations, fire rated, and non-fire rated, top of sleeve shall extend 1 inch above the adjacent finished floor. In existing floor penetrations, core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting, non-shrink grout. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to existing floor structure.
- E For floor penetrations through existing floors in mechanical and wet locations listed below, core drill opening and provide 1-1/2" x 1-1/2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from entering the penetration. Provide urethane caulk between angles and floor and fasten angles to floor a minimum of 8" on center. Seal corners watertight with urethane caulk. Or core drill sleeve openings large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting non-shrink grout/cement.
- F Wet locations include:
 - 1. Exterior Locations
- G For pipe penetrations through existing floors in food service areas, core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting non-shrink grout/cement. Size sleeve to allow insulated pipe to pass through sleeve and paint the sleeve.
- H Pipe sleeves are not required in cored floor pipe penetrations through existing floors that are not located in mechanical rooms, food service areas or wet locations listed above.

3.12 SEALING AND FIRESTOPPING

- A FIRE AND/OR SMOKE RATED PENETRATIONS:
 - 1. Install approved product in accordance with the manufacturer's instructions where a pipe penetrates a fire/smoke rated surface. When pipe is insulated, use a product which maintains the integrity of the insulation and vapor barrier.
 - 2. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support substantial weight.
- B NON-RATED PARTITIONS:
 - 1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with manufacturer's instructions.

2. At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.

3.13 OWNER TRAINING

- A Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 2 hours.

END OF SECTION 22 05 00

INTENTIONALLY LEFT BLANK

SECTION 22 05 14 PLUMBING SPECIALTIES

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for floor drains, roof drains, cleanouts, backflow preventers, water hammer arrestors and other miscellaneous plumbing specialties.
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Documents.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operation and Maintenance Data.
 2. PART 2 – PRODUCTS.
 - a. Floor Drains.
 - b. Trap Guards.
 - c. Floor Sinks.
 - d. Hub Drains.
 - e. Cleanouts.
 - f. Water Hammer Arrestors.
 - g. Backflow Preventers.
 - h. Wall Hydrants.
 - i. Hose Bibbs.
 - j. Safings.
 - k. Vent Flashings.
 3. PART 3 – EXECUTION.
 - a. Installation.

1.02 RELATED DOCUMENTS

- A Section 22 05 23 - General-Duty Valves for Plumbing Piping.
B Section 22 11 00 - Facility Water Distribution.
C Section 22 13 00 - Facility Sanitary Sewerage.

1.03 REFERENCE

- A Applicable provisions of Division 1 shall govern work under this section.

1.04 REFERENCE STANDARDS

- A ANSI A112.21.1 - Floor Drains.
B ANSI A112.26.1/PDI WH-201 - Water Hammer Arrestors.
C ASSE 1001 - Pipe Applied Atmospheric Type Vacuum Breakers.
D ASSE 1010 - Water Hammer Arrestors.
E ASSE 1011 - Hose Connection Vacuum Breakers.
F ASSE 1012 - Backflow Preventers with Intermediate Atmospheric Vent.
G ASSE 1013 - Reduced Pressure Principle Backflow Preventers.
H ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining, Anti-Backflow Type.

1.05 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B Plumbing products requiring approval by the State of Wisconsin must be approved or have pending approval at the time of shop drawing submission.

1.06 SHOP DRAWINGS

- A Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B Include data concerning dimensions, capacities, materials of construction, ratings, certifications, weights, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 - Closeout Submittals.

PART 2 PRODUCTS

2.01 REFER TO SHEET P001 FOR MORE INFORMATION REGARDING PLUMBING FIXTURES AND EQUIPMENT.

2.02 FLOOR DRAINS

- A Manufacturer:
 - 1. Josam: www.josam.com.
 - 2. Smith: www.jrsmith.com.
 - 3. Wade: www.wadedrains.com.
 - 4. Watts: www.watts.com.
 - 5. Zurn: www.zurn.com.
- B 3" min. (2" min. for single shower drains) enameled cast iron two piece body with double drainage flange, weep holes, reversible clamping adjustable collar, adjustable 6" x 6" min. square or round polished nickel-bronze strainer with threaded collar, bottom outlet, with the addition of the trap guard diaphragm called out below.

2.03 TRAP GUARDS

- A Manufacturer: ProSet Systems Trap Guard or approved equal.
- B Flexible elastomeric PVC construction diaphragm trap guard for installation in new and existing floor drains, hub drains, and trench drains. Trap guard to prevent trap evaporation and waste backflow. Size as applicable to the drain outlet size, up to 4" size.

2.04 FLOOR SINKS

- A Manufacturer:
 - 1. Josam: www.josam.com.
 - 2. Smith: www.jrsmith.com.
 - 3. Wade: www.wadedrains.com.
 - 4. Watts: www.watts.com.
 - 5. Zurn: www.zurn.com.
- B 4" deep cast iron body, 8" x 8" x 6" deep with white epoxy enameled coated interior and square slotted medium duty top grate, with aluminum interior bottom dome strainer, with anchor flange and/or seepage holes and clamping collar for above grade installation.

2.05 HUB DRAINS

- A Manufacturer:
 - 1. Josam: www.josam.com.
 - 2. Smith: www.jrsmith.com.

3. Wade: www.wadedrains.com.
 4. Watts: www.watts.com.
 5. Zurn: www.zurn.com.
- B 3" min. cast iron hub section up 2" min. above floor level, with full-sized deep seal P-trap, with the addition of the trap guard diaphragm called out above.

2.06 CLEANOUTS

- A Manufacturer:
1. Josam: www.josam.com.
 2. Smith: www.jrsmith.com.
 3. Wade: www.wadedrains.com.
 4. Watts: www.watts.com.
 5. Zurn: www.zurn.com.
- B INTERIOR CONCRETE FLOOR AREAS: Enameled cast iron body with round adjustable scoriated polished nickel bronze cover, tapered threaded ABS closure plug.
- C INTERIOR CERAMIC TILE FLOOR AREAS: Enameled cast iron body with square adjustable scoriated nickel bronze cover, tapered threaded ABS closure plug.
- D INTERIOR VINYL TILE FLOOR AREAS: Enameled cast iron body with round adjustable scoriated nickel bronze cover, tapered threaded ABS closure plug.
- E INTERIOR CARPETED FLOOR AREAS: Enameled cast iron body with round adjustable scoriated nickel bronze cover and secured carpet marker, tapered threaded ABS closure plug. Zurn Z-1400-CM.
- F INTERIOR FINISHED WALL AREAS: Line type cleanout tee with tapered threaded ABS cleanout plug, round polished stainless steel access cover secured with machine screw. (Note: Screw shall not pass completely through the ABS plug, trim screw as necessary).
- G INTERIOR EXPOSED VERTICAL STACKS: Line type cleanout tee with tapered threaded ABS closure plug. Zurn Z-1445.
- H INTERIOR HORIZONTAL LINES: Cast iron hub with tapped ferrule and tapered threaded ABS or PVC closure plug, or no-hub coupling and blind plug.
- I EXTERIOR PAVED AREAS: Cast iron hub or plug with tapered threaded ABS or PVC closure plug, cast iron frost sleeve and cover set in 24" square by 4" min. thick reinforced concrete pad top or surrounding pavement, crowned for drainage
- J EXTERIOR UNPAVED AREAS: Cast iron hub or plug with tapered threaded ABS or PVC closure plug, cast iron or PVC frost sleeve and cover set in 24" square by 4" min. thick reinforced concrete pad top.

2.07 WATER HAMMER ARRESTORS

- A Manufacturer:
1. PPP Industries: www.pppinc.com.
 2. Sioux Chief: www.siouxchief.com.
 3. Wade: www.wadedrains.com.
 4. Watts: www.watts.com.
- B ANSI A112.26.1, ASSE 1010; sized in accordance with PDI WH-201, precharged piston type constructed of hard drawn Type K copper, threaded brass adapter, brass piston with o-ring seals, FDA approved silicone lubricant, suitable for operation in temperature range 35 to 150 degrees F, maximum 250 psig working pressure, 1500 psig surge pressure.

2.08 BACKFLOW PREVENTERS

- A Manufacturers:
1. Beeco: www.bykowskiequipment.com.
 2. Cla-Val: www.cla-val.com.
 3. Conbraco: www.conbraco.com.
 4. Febco: www.febcoonline.com.
 5. Watts: www.watts.com.
 6. Wilkins: www.zurn.com.
- B HOSE CONNECTION VACUUM BREAKERS: ASSE 1011, brass or bronze construction, EPDM diaphragm and seat, rated for 125 psig and 180°F. Watts 8 (interior application).
- C DUAL CHECK WITH ATMOSPHERIC VENT FOR CO₂ POST MIX VENDING MACHINES: 3/8", stainless steel body and parts, dual check with third ball check outlet, rated for 150 psig and 140°F. Watts 9BD.
- D INTERMEDIATE ATMOSPHERIC VENTED BACKFLOW PREVENTERS: ASSE 1012, same size as pipe, with intermediate atmospheric vent between independent check valves, bronze body with union ends, stainless steel springs, rated for 175 psig and 210°F. Watts 9DM.

2.09 WALL HYDRANTS

- A Manufacturer:
1. Josam: www.josam.com.
 2. Smith: www.jrsmith.com.
 3. Wade: www.wadedrains.com.
 4. Watts: www.watts.com.
 5. Woodford: www.woodfordmfg.com.
 6. Zurn: www.zurn.com.
- B Freezeproof automatic draining wall hydrant in flush mounted cast brass wall box with locking door, 3/4" inlet, 3/4" hose thread ASSE 1019-93 backflow preventer outlet, loose key operator, polished brass finish. Woodford model B65, RB65, B67 or RB67 series.

2.10 HOSE BIBBS

- A Bronze or brass construction hose faucet/valve, cast iron handwheel, replaceable disc, hose thread spout, with ASSE 1011 backflow preventer outlet, 3/4" size.

2.11 SAFINGS

- A Manufacturers:
1. Noble: www.noblegroupusa.com.
 2. Oatey: www.oatey.com.
- B Chlorinated polyethylene sheeting, 40 mils thick, ASTM D4068, joined with CPE solvent: or 3 lb./sq. ft. sheet lead.

2.12 VENT FLASHINGS

- A Manufacturers:
1. Semco: www.semcoinc.com.
 2. Oatey: www.oatey.com.
- B Formed 3 lb./sq. ft. lead flashing with minimum base size of 15" x 17".
- C Single Ply Membrane Roofs: Flashing boot of material compatible with roofing membrane with base flange for adhering to membrane and stainless steel drawband for securing to vent pipe.

PART 3 EXECUTION

3.01 INSTALLATION

- A Coordinate location and setting of plumbing specialties with adjacent construction. Install in accordance with manufacturers recommendations.
- B Set floor drains and cleanouts level and plumb adjusted to finished floor elevation, roof elevation or finished wall location. Locate where serviceable. Allow minimum of 18" clearance around cleanouts for rodding. Lubricate threaded cleanout plugs with graphite and oil, teflon tape or waterproof grease. Install trap primer connections where indicated. Provide deep seal traps on floor drains and hub drains installed in mechanical rooms, penthouses or rooms with excessive positive or negative pressure.
- C Floor drains and hub drains installed in public restrooms, locker rooms, seldom used rooms, and areas with minute drainage flow shall have installations of combination trap evaporation/backflow preventer diaphragm installations.
- D Install water hammer arrestors where indicated and at quick closing valve installations.
- E Install backflow preventers in accordance with the State of Wisconsin requirements maintaining minimum clearance distances for servicing and testing. Provide indirect waste piping with air gap installation from relief opening to above hub drain or floor drain.
- F Install lab faucet vacuum breakers with Loctite 242 "blue" on threads.
- G Where backflow preventers requiring the State of Wisconsin registration are installed, provide initial registration, testing and report filing required by the State of Wisconsin. List the name and address of the building that the backflow preventer installations occur in.
- H Mount wall hydrants recessed in exterior wall construction with valve plug extended beyond interior side of building insulation. Slope to drain to exterior. Install so discharge is 18" min. above finished grade. Set wall box in grout or caulk and fill exterior wall penetration with insulation.
- I Mount yard hydrants with discharge 27" min. above finished grade. Set base of hydrant in 1 cu. yd. of granular backfill material for free drainage. Crown finished grade materials for drainage away from hydrant.
- J Mount hose bibbs securely fastened to wall where indicated. Provide water hammer arrestor in line to hose bibb.
- K Install safing at floor drains above grade. Extend 12" beyond drains in all directions. Cover entire floor in showers and extend 6" up in walls above curbs and to a height of 6' (3" wide each direction) in corners. Install on concrete floor that is smooth and free of debris. Seal all joints and connect to drain body clamp. Safing is subject to standing water leak test. Install safing at all built-up shower installations. (Note: spray-on and brush applied liquid safing is not acceptable).
- L Flash vent penetrations through roof. Turn down top of lead flashing into vent pipe. Tighten drawband of membrane boot to vent pipe. Adhere base flashing to deck or membrane. Provide waterproof patch around penetration on existing roofs.
- M Install washing machine boxes in wall construction, secured to structure, directly behind proposed washing machine location. Provide water hammer arrestors in supply piping. Mount box a min. of 36" above floor.

END OF SECTION 22 05 14

INTENTIONALLY LEFT BLANK

SECTION 22 05 15 PIPING SPECIALTIES

PART 1 GENERAL

1.01 SCOPE

- A This section contains specifications for plumbing piping specialties for all piping systems. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operation and Maintenance Data.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Thermometers.
 - b. Thermometer Sockets.
 - c. Test Wells.
 - d. Test Plugs.
 - e. Pressure Gauges.
 - f. Strainers.
 3. PART 3 – EXECUTION.
 - a. Thermometers.
 - b. Thermometer Sockets.
 - c. Test Wells.
 - d. Test Plugs.
 - e. Pressure Gauges.
 - f. Strainers.

1.02 RELATED WORK

- A Section 22 05 23 - General-Duty Valves for Plumbing Piping.
B Section 22 07 00 - Plumbing Insulation.
C Section 22 11 00 - Facility Water Distribution.
D Section 22 13 00 - Facility Sanitary Sewerage.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ASTM B650 Electrodeposited Engineering Chromium Coatings on Ferrous Substrates.

1.05 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 – Products Requirements.

1.06 SHOP DRAWINGS

- A Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.

- B Required for all items in this section. Include materials of construction, dimensional data, ratings/capacities/ranges, approvals, test data, pressure drop data where appropriate, and identification as referenced in this section and/or on the drawings.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 – Closeout Submittals.

1.08 DESIGN CRITERIA

- A All piping specialties are to be rated for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

PART 2 PRODUCTS

2.01 THERMOMETERS

- A Manufacturers:
1. Ashcroft: www.ashcroft.com.
 2. Marsh: www.marshinstruments.com.
 3. Taylor: www.taylorusa.com.
 4. H. O. Trerice: www.trerice.com.
 5. Ametek/U. S. Gauge: www.ametekusg.com.
 6. Weiss: www.weissinstruments.com.
 7. Wika: www.wikagauges.com.
 8. Weksler: www.weksler-gauges.com.
- B Stem Type: Cast aluminum case, nine inch scale, clear acrylic window. adjustable angle brass stem with stem of sufficient length so the end of the stem is near the middle of a pipe without reducing the thickness of any insulation, red indicating fluid, black lettering against a white background, with scale ranges as follows:

Service	Hot Water
Scale Range, °F	30 - 180
Increment, °F	2

2.02 THERMOMETER SOCKETS

- A Brass with threaded connections suitable for thermometer stems and temperature control sensing elements in pipeline. Furnish with extension necks for insulated piping systems.

2.03 TEST WELLS

- A Similar to thermometer sockets except with a brass cap that threads into the inside of the test well to prevent dirt from accumulating. Secure cap to body with a short chain. Furnish with extension necks, where appropriate, to accommodate the pipeline insulation.

2.04 TEST PLUGS

- A Brass threaded pressure and temperature test plug with neoprene self-closing valve, valve retainer, brass threaded cap, rated for 150 psi and 0-200 degrees F.

2.05 PRESSURE GAUGES

- A Manufacturers:
1. Ametek/U. S. Gauge: www.ametekusg.com.
 2. Ashcroft: www.ashcroft.com.
 3. Marsh: www.marshinstruments.com.
 4. Taylor: www.taylorusa.com.
 5. H. O. Trerice: www.trerice.com.

6. Weiss: www.weissinstruments.com.
 7. Wika: www.wikagauges.com.
 8. Weksler: www.weksler-gauges.com.
- B Cast aluminum case of not less than 4.5 inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from the front of the dial, 99% accuracy over the middle half of the scale, 98.5% accuracy over the remainder of the scale, with scale range as follows:
- | Service | Hot Water | Cold Water |
|-------------------|-----------|------------|
| Scale Range, psig | 0-100 | 0-100 |
| Increment, psig | 1 | 1 |
- C Pressure Snubbers: Bronze construction, 300 psig working pressure, 1/4" size.
- D Gauge Valves: Use ball valves as specified in Section 22 05 23 - General-Duty Valves for Plumbing Piping.

2.06 STRAINERS

- A Manufacturers:
1. Armstrong: www.armstronginternational.com.
 2. Illinois: www.illinoispiping.com.
 3. Keckley: www.keckley.com.
 4. Metraflex: www.metraflex.com.
 5. Mueller Steam: www.muellersteam.com.
 6. Sarco: www.spiraxsarco.com.
 7. Watts: www.watts.com.
- B Y type; cast bronze body, ASTM B62; 20 mesh stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; sweat, threaded or flanged body rated at not less than 150 psi WOG.
- C Y type; cast iron body, ASTM A126; 20 mesh stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; threaded or flanged ends; rated at not less than 150 psi WOG.

PART 3 EXECUTION

3.01 THERMOMETERS

- A Stem Type: Install in piping systems as indicated on the drawings and/or details using a separable socket in each location.

3.02 THERMOMETER SOCKETS

- A Install at each point where a thermometer or temperature control sensing element is located in a pipeline.

3.03 TEST WELLS

- A Install in piping systems as indicated on the drawings and/or details wherever provisions are needed for inserting a thermometer at a later date.

3.04 TEST PLUGS

- A Install in piping systems as indicated on the drawings and/or details wherever provisions are needed for short-term measurement of pressure or temperature.

3.05 PRESSURE GAUGES

- A Install in locations where indicated on the drawings and/or details, with scale range appropriate to the system operating pressures.
- B Pressure Snubbers: Install in gauge piping for all gauges used on water services.
- C Gauge Valves: Install at each gauge location as close to the main as possible and at each location where a gauge tapping is indicated.

3.06 STRAINERS

- A Install all strainers where indicated allowing sufficient space for the screens to be removed. Install a ball valve in the tapped screen retainer.

END OF SECTION 22 05 15

SECTION 22 05 23
GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SCOPE

- A This section includes valve specifications for all Plumbing systems except where indicated under Related Work. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Lead Free Requirements
 - e. Quality Assurance.
 - f. Submittals.
 - g. Operation and Maintenance Data.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Water System Valves:
 - 1) Ball Valves.
 - 2) Butterfly Valves.
 - 3) Spring Loaded Check Valves.
 - 4) Balance Valves.
 - 5) Drain Valves.
 - b. Natural Gas Systems:
 - 1) Shut-off Valves.
 - 2) Gas Pressure Regulators.
 - c. Specialty Valves and Valve Accessories:
 - 1) Gauge Valves.
 - 2) Safety Relief Valves.
 3. PART 3 – EXECUTION.
 - a. General.
 - b. Shut-off Valves.
 - c. Balancing Valves.
 - d. Drain Valves.
 - e. Spring Loaded Check Valves.
 - f. Safety Relief Valves.
 - g. Gas Pressure Regulators.

1.02 RELATED WORK

- A Section 22 05 00 - Common Work Results for Plumbing.
B Section 22 05 14 - Plumbing Specialties.
C Section 22 30 00 - Plumbing Equipment.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 LEAD FREE REQUIREMENTS

- A All materials that contact potable water shall be lead free. Lead free refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per the Federal Safe Drinking Water Act as amended January 4, 2011 Section 1417.

1.05 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 – Product Requirements.

1.06 SUBMITTALS

- A Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B Schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on the project. Temperature ratings specified are for continuous operation.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 – Closeout Submittals.

1.08 DESIGN CRITERIA

- A ANSI Z21.22 - Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems.
- B ASSE 1003 - Water Pressure Reducing Valves for Domestic Water Supply Systems.
- C Where valve types (ball, butterfly, etc.) are specified for individual plumbing services (i.e. domestic water, gas, etc.), each valve type shall be of the same manufacturer unless prior written approval is obtained from the Owner.
- D Valves to be line size unless specifically noted otherwise.

PART 2 PRODUCTS

2.01 WATER SYSTEM VALVES

- A All water system valves to be rated at not less than 125 water working pressure at 240 degrees F unless noted otherwise.
- B BALL VALVES:
 - 1. 3" and smaller: Two piece bronze body; sweat or threaded ends, chrome plated bronze ball; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 600 psig WOG. Provide valve stem extensions for valves installed in all piping with insulation.
 - a. Manufacturers:
 - 1) Apollo 70LF-200: www.apollovalves.com.
 - 2) Hammond UP8511: www.hammondvalve.com.
 - 3) Milwaukee UPBA150: www.milwaukeevalve.com.
 - 4) Nibco S580-80-LF: www.nibco.com.
 - 5) Watts LFB-6081G2: www.watts.com.
- C BUTTERFLY VALVES:
 - 1. 2-1/2" and larger: Cast or ductile iron body; stainless steel shaft; bronze, copper or teflon bushings; EPDM resilient seat; EPDM seals; bronze, aluminum-bronze, EPDM encapsulated ductile iron or stainless steel disc. 200 psig WOG through 12", 150 psig WOG through 24". Valve assembly to be bubble tight to 175 psig with no downstream flange/pipe attached. Use tapped lug type valves with stud bolts or cap screws, or grooved end connection valves, permitting removal of downstream piping while using the valve for system shutoff.
 - a. Manufacturers:
 - 1) Hammond 5200 or 6200 series: www.hammondvalve.com.

- 2) Milwaukee M or C Series: www.milwaukeevalve.com.
 - 3) Nibco LD2000/LC2860: www.nibco.com.
 - 4) Victaulic 608: www.victaulic.com.
 - 5) Watts BF-03-M2: www.watts.com.
2. Provide 10 position locking lever handle actuators for valves 6" and smaller. Provide worm gear operators with external position indication for valves 8" and larger.
- D SPRING LOADED CHECK VALVES:
1. 2" and smaller: Bronze body, sweat or threaded ends, bronze trim, stainless steel spring, stainless steel center guide pin, Class 125, teflon seat unless only bronze available.
 - a. Manufacturers:
 - 1) ConBraCo 61 series: www.conbraco.com.
 - 2) Nibco S480-Y-LF: www.nibco.com.
 - 3) Val-Matic S1400 series: www.valmatic.com.
 - 4) Watts LF600: www.watts.com.
 2. 2-1/2" and larger: Cast or ductile iron body, wafer or globe type, bronze trim, bronze or EPDM seat, stainless steel spring, stainless steel stem if stem is required, Class 125.
 - a. Manufacturers:
 - 1) Hammond IR9253 or IR9354: www.hammondvalve.com.
 - 2) Milwaukee 1400 or 1800 series: www.milwaukeevalve.com.
 - 3) Nibco W910-LF or F910-LF: www.nibco.com.
- E BALANCE VALVES:
1. 2" and smaller: sweat or threaded ends, chrome plated brass ball, glass filled teflon seat, threaded packing nut, with adjustable memory stop position indicator and extended handle stem, suitable for 400 psig water working pressure at 240 degrees F.
 - a. Manufacturers:
 - 1) Nibco S580-80-LF: www.nibco.com.
 - 2) Hammond UP8501-02 or UP8511-02: www.hammondvalve.com.
 - 3) Milwaukee UPBA-100MS or UPBA-150MS: www.milwaukeevalve.com.
 - 4) Watts: www.watts.com.
 - 5) Apollo: www.apollovalves.com.
- F DRAIN VALVES:
1. 3/4 inch ball valve with integral threaded hose adapter, sweat or threaded inlet connections, with threaded cap and chain on hose threads.
 - a. Manufacturers:
 - 1) Apollo70LF-200-HC: www.apollovalves.com.
 - 2) Milwaukee BA-100H or BA-150H: www.milwaukeevalve.com.
 - 3) Hammond 8501H or 8511H: www.hammondvalve.com.
 - 4) Nibco: www.nibco.com.
 - 5) Watts: www.watts.com.

2.02 NATURAL GAS SYSTEMS

A SHUT-OFF VALVES:

1. 4" and smaller: Ball or eccentric plug valve, bronze or cast iron body, 2" and under threaded ends, 2-1/2" and over flanged ends, chrome plated bronze ball, bronze or nickel plated cast iron plug.

2. TFE or Hycar seats and seals, lever handle, 175 psi W.O.G., U.L listed for use as natural gas shut-off.
 - a. Manufacturers:
 - 1) Apollo; 80-100: www.apollovalves.com.
 - 2) DeZurik; 425: www.dezurik.com.
 - 3) Milwaukee: www.milwaukeevalve.com.
 - 4) Nibco: www.nibco.com.
 - 5) Watts: www.watts.com.
 3. 5" and larger: Cast iron body, flanged ends, stainless steel bearings, resilient faced plugs, totally enclosed hand wheel actuators, 175 psi W.O.G., U.L. listed for use as natural gas shut-off.
- B GAS PRESSURE REGULATORS:
1. 2" and smaller: Cast iron body, aluminum spring and diaphragm, Nitrile diaphragm, threaded ends, 150 psi W.O.G., -20 degrees F to 150 degrees F.

2.03 SPECIALTY VALVES AND VALVE ACCESSORIES

A GAUGE VALVES:

1. Use 1/4" ball valves. Needle valves and gauge cocks will not be accepted.

B SAFETY RELIEF VALVES:

1. Bronze body, temperature and pressure actuated, stainless steel stem and spring, thermostat with non-metallic coating, test lever, suitable for 125 psig water working pressure at 240 degrees F, sized for full BTUH input and operating pressure of equipment, with valve capacity on metal label. For equipment less than or equal to 200,000 BTUH input, provide AGA, UL or ASME listed and labeled valve. Provide ASME listed and labeled valve for larger equipment.
2. Temperature and pressure relief valve shall be sized per AGA rating for BTUH input, Re: SPS 382.40(5)(d).
 - a. Manufacturers:
 - 1) Bell & Gossett: www.bellgossett.com.
 - 2) A. W. Cash: www.cashvalve.com.
 - 3) Conbraco: www.conbraco.com.
 - 4) Watts: www.watts.com.
 - 5) Wilkins: www.zurn.com.

PART 3 EXECUTION

3.01 GENERAL

- A Properly align piping before installation of valves. Install and test valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends.
- B Mount valves in locations which allow access for operation, servicing and replacement.
- C Provide valve handle extensions for all valves installed in insulated piping.
- D Install all valves with the stem in the upright or horizontal position. If possible, install butterfly valves with the stem in the horizontal position. Valves installed with the stems down will not be accepted.
- E Prior to flushing of piping systems, place all valves in the full-open position.

3.02 SHUT-OFF VALVES

- A Install shut-off valves at each piece of equipment, at each branch take-off from mains for isolation or repair and elsewhere as indicated.

3.03 BALANCING VALVES

- A Install where indicated on the drawings and details for balancing of flow in pumped hot water recirculation piping systems.
- B Upon project completion, adjust each valve and set position stop. Balance system to minimum flow in return piping branches needed to maintain even supply water temperature throughout building.

3.04 DRAIN VALVES

- A Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping systems, downstream of riser isolation valves, equipment locations specified or detailed, other locations required for drainage of systems and elsewhere as indicated.

3.05 SPRING LOADED CHECK VALVES

- A Install a spring loaded check valve in each circulating pump discharge line, each clear water sump pump discharge line and elsewhere as indicated.

3.06 SAFETY RELIEF VALVES

- A Install relief valves on all pressure vessels and elsewhere as indicated. Inlet and outlet piping connecting to valves must be the same size as valve connections or larger. Pipe discharge to drain where indicated or to floor.

3.07 GAS PRESSURE REGULATORS

- A When the gas pressure regulator is equipped with a vent connection, run a connection size vent to outside air in accordance with codes. Use a larger size vent when required by the manufacturer's installation instructions.

END OF SECTION 22 05 23

INTENTIONALLY LEFT BLANK

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING AND PIPING EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for supports of all plumbing equipment and materials as well as piping system anchors. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Description.
 - g. Shop Drawings.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Pipe Hangers and Supports.
 - c. Pipe Hanger Rods.
 - d. Beam Clamps.
 - e. Concrete Inserts.
 - f. Equipment Stands
 - g. Corrosive Atmosphere Coatings.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Hanger and Support Spacing.
 - c. Riser Clamps.

1.02 RELATED WORK

- A Section 22 07 00 - Plumbing Insulation for insulation protection at support devices.

1.03 REFERENCE

- A Applicable provisions of Division 1 shall govern work under this section.

1.04 REFERENCE STANDARDS

- A MSS SP-58.
B MSS SP-69.

1.05 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 – Product Requirements.

1.06 DESCRIPTION

- A Provide all supporting devices as required for the installation of mechanical equipment and materials.
B All supports and installation procedures are to conform to the latest requirements of the ANSI Code for building piping.
C Do not hang any mechanical item directly from a metal deck or run piping so its rests on the bottom chord of any truss or joist.

- D Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.
- E Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.
- F Protect insulation at all hanger points; see Related Work above.

1.07 SHOP DRAWINGS

- A Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B Schedule of all hanger and support devices indicating attachment methods and type of device for each pipe size and type of service.

1.08 DESIGN CRITERIA

- A Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.
- B Piping connected to pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Anvil: www.anvilintl.com.
- B B-Line: www.bline.com.
- C Pate: www.patecurbs.com.
- D Piping Technology: www.pipingtech.com.
- E Roof Products & Systems: www.commercialproductsgroup.com.

2.02 PIPE HANGERS AND SUPPORTS

- A HANGERS FOR PIPE SIZES 1/2" THROUGH 2":
 - 1. Carbon steel, adjustable swivel ring. B-Line B3170NF, Anvil 69 or 70.
 - 2. Carbon steel, adjustable clevis, standard. B-Line B3100, Anvil 260.
- B HANGERS FOR PIPE SIZES 2" AND LARGER:
 - 1. Carbon steel, adjustable clevis, standard. B-Line B3100, Anvil 260.
- C MULTIPLE OR TRAPEZE HANGERS:
 - 1. Steel channels with welded spacers and hanger rods.
- D WALL SUPPORT:
 - 1. Carbon steel welded bracket with hanger. B-Line 3068 Series, Anvil 194 Series.
 - 2. Perforated, epoxy painted finish, 16-12 gauge, min., steel channels securely anchored to wall structure, with interlocking, split-type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Anvil type PS 200 H with PS 1200 clamps. When copper piping is being supported, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Anvil PS 1400 series.
- E VERTICAL SUPPORT:
 - 1. Carbon steel riser clamp. B-Line B3373, Anvil 261 for above floor use.
- F FLOOR SUPPORT:
 - 1. Carbon steel pipe saddle, stand and bolted floor flange. B-Line B3088T/B3093.

G COPPER PIPE SUPPORTS:

1. All supports, fasteners, clamps, etc. directly connected to copper piping shall be copper plated or polyvinylchloride coated. Where steel channels are used, provide isolation collar between supports/clamps/fasteners and copper piping.

2.03 PIPE HANGER RODS

A STEEL HANGER RODS:

1. Threaded both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
2. Size rods for individual hangers and trapeze support as indicated in the following schedule.
3. Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2
1810	5/8
2710	3/4
3770	7/8
4960	1
8000	1-1/4

2.04 BEAM CLAMPS

- A MSS SP-69 Types 19 & 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick with a retaining ring and threaded rod of 3/8, 1/2, and 5/8 inch diameter. Furnish with a hardened steel cup point set screw. B-Line B3036L/B3034, Anvil 86/92.
- B MSS SP-69 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter. B-Line B3054, Anvil 228.

2.05 CONCRETE INSERTS

A DRILLED FASTENERS:

1. Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor.
2. Manufacturers:
 - a. Hilti: www.hilti.com.
 - b. Rawl: www.rawl.com.
 - c. Redhead: www.ramset-redhead.com.

2.06 EQUIPMENT STANDS

- A Use structural steel members welded to and supported by pipe supports. Clean, prime and coat with three coat rust inhibiting alkyd paint or one coat epoxy mastic. Where exposed to weather, treat with corrosive atmosphere coatings.

2.07 CORROSIVE ATMOSPHERE COATINGS

- A Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication, ASTM A123, 1.5 ounces/square foot of surface each side. Mechanical galvanize threaded products, ASTM B695 Class 50, 2.0 mil coating. Field cuts and damaged finishes to be field covered with zinc rich paint of comparable thickness to factory coating.

B Corrosive atmospheres include the following locations:

1. Exterior locations.
2. Food service/kitchen areas.

PART 3 EXECUTION

3.01 INSTALLATION

- A Size, apply and install supports and anchors in compliance with manufacturers recommendations.
- B Install supports to provide for free expansion of the piping system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.
- C Coordinate hanger and support installation to properly group piping of all trades.
- D Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes or continuous insert channels for the supporting steel. Where continuous insert channels are used, pipe supporting devices made specifically for use with the channels may be substituted for the specified supporting devices provided that similar types are used, and all data is submitted for prior approval.
- E Size and install hangers and supports, except for riser clamps, for installation on the exterior of piping insulation. Where a vapor barrier is not required, hangers may be installed either on the exterior of pipe insulation or directly on piping.
- F Perform welding in accordance with standards of the American Welding Society.

3.02 HANGER AND SUPPORT SPACING

- A Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- B Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item.
- C Use hangers with 1-1/2 inch minimum vertical adjustment.
- D Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.
- E Support riser piping independently of connected horizontal piping.
- F Adjust hangers to obtain the slope specified in the piping section of these specifications.
- G Space hangers for pipe as follows:

Pipe Material	Pipe Size	Max. Horiz. Spacing	Max. Vert. Spacing
Cast Iron	2" and larger	5'-0"	15'-0"
Copper	1/2" through 3/4"	5'-0"	10'-0"
Copper	1" through 1-1/4"	6'-0"	10'-0"
Copper	1-1/2" through 2-1/2"	8'-0"	10'-0"
Copper	3"	10'-0"	10'-0"
Ductile Iron	All	10'-0"	20'-0"
Plastic	Drain and Vent	4'-0"	10'-0"
Plastic	1" or less	32"	4'-0"
Plastic	1-1/4" and over	4'-0"	6'-0"

3.03 RISER CLAMPS

- A Support vertical piping with clamps secured to the piping and resting on the building structure or secured to the building structure below at each floor.

END OF SECTION 22 05 29

SECTION 22 07 00 PLUMBING INSULATION

PART 1 GENERAL

1.01 SCOPE

- A This section includes insulation specifications for plumbing piping and equipment. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Description.
 - g. Definitions.
 - h. Shop Drawings.
 - i. Operation and Maintenance Data.
 2. PART 2 – PRODUCTS.
 - a. Materials.
 - b. Insulation & Jackets.
 - c. Insulation Inserts and Pipe Shields.
 - d. Accessories.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Piping, Valve and Fitting Insulation.

1.02 RELATED WORK

- A Section 22 05 00 - Common Work Results for Plumbing.
B Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
C Section 22 11 00 - Facility Water Distribution.
D Section 22 13 00 - Facility Sanitary Sewerage.
E Section 22 30 00 - Plumbing Equipment.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate.
B ASTM C165 Test Method for Compressive Properties of Thermal Insulations.
C ASTM C177 Heat Flux and Thermal Transmission Properties.
D ASTM C195 Mineral Fiber Thermal Insulation Cement.
E ASTM C240 Cellular Glass Insulation Block.
F ASTM C302 Density of Preformed Pipe Insulation.
G ASTM C303 Density of Preformed Block Insulation.
H ASTM C449 Mineral Fiber Hydraulic Setting Thermal Insulation Cement.
I ASTM C518 Heat Flux and Thermal Transmission Properties.
J ASTM C533 Calcium Silicate Block and Pipe Thermal Insulation.

K	ASTM C534	Preformed Flexible Elastomeric Thermal Insulation.
L	ASTM C547	Mineral Fiber Preformed Pipe Insulation.
M	ASTM C552	Cellular Glass Block and Pipe Thermal Insulation.
N	ASTM C553	Mineral Fiber Blanket and Felt Insulation.
O	ASTM C578	Preformed, Block Type Cellular Polystyrene Thermal Insulation.
P	ASTM C591	Preformed Rigid Cellular Polyurethane Thermal Insulation.
Q	ASTM C610	Expanded Perlite Block and Thermal Pipe Insulation.
R	ASTM C612	Mineral Fiber Block and Board Thermal Insulation.
S	ASTM C921	Properties of Jacketing Materials for Thermal Insulation.
T	ASTM C1136	Flexible Low Permeance Vapor Retarders for Thermal Insulation.
U	ASTM E84	Surface Burning Characteristics of Building Materials.
V	MICA	National Commercial & Industrial Insulation Standards.
W	NFPA 225	Surface Burning Characteristics of Building Materials.
X	UL 723	Surface Burning Characteristics of Building Materials.

1.05 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 – Product Requirements.
- B Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.

1.06 DESCRIPTION

- A Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:
 - 1. Pipe Insulation.
 - 2. Equipment Insulation.
- B Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these specifications, or where prior written approval has been obtained from the Owner.

1.07 DEFINITIONS

- A Concealed: shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

1.08 SHOP DRAWINGS

- A Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

1.09 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 - Closeout Submittals.

PART 2 PRODUCTS

2.01 MATERIALS

- A Materials or accessories containing asbestos will not be accepted.

- B Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exceptions:
1. Insulation which is not located in an air plenum shall have a flame spread rating not over 25 and a smoke developed rating no higher than 150.

2.02 INSULATION AND JACKETS

- A Manufacturers:
1. Armstrong: www.armstronginternational.com.
 2. Certainteed: www.certainteed.com.
 3. Manson: www.imanson.com.
 4. Childers: fosterproducts.com.
 5. Dow: www.dow.com.
 6. Extol: www.extol.com.
 7. Halstead: www.rembco.com.
 8. H.B. Fuller: www.hbfuller.com
 9. Imcoa: www.nomacoinsulation.com.
 10. Knauf: www.knaufusa.com.
 11. Owens-Corning: www.owenscorning.com.
 12. Pittsburgh Corning: www.foamglasinsulation.com.
 13. Johns-Mansville: www.jm.com.
- B Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.
- C RIGID FIBERGLASS INSULATION:
1. Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 degrees F.
 2. White kraft reinforced foil vapor barrier all service jacket, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.
- D PVC FITTING COVERS AND JACKETS:
1. White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be .02 inch (20 mil).
- E METAL JACKETS:
1. .016 inch thick aluminum or .010 inch thick stainless steel with safety edge.

2.03 INSULATION INSERTS AND PIPE SHIELDS

- A Manufacturers:
1. B-Line: www.bline.com.
 2. Pipe Shields: www.pipeshieldinc.com.
 3. Value Engineered Products: www.valueng.com.
- B Construct inserts with calcium silicate, minimum 140 psi compressive strength. Piping 12" and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield.

- C Insert and shield to be minimum 180 degree coverage on bottom of supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.
- D Where Contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to pre-engineered pre-manufactured product described above. On low temperature systems, extruded polystyrene shall be substituted for calcium silicate provided insert and shield length and gauge are increased to compensate for lower insulation compressive strength.
- E Pre-compressed 20# density molded fiberglass blocks, Hamfab or equal, of same thickness as adjacent insulation shall be substituted for calcium silicate inserts with one 1" x 6" block for piping through 2-1/2" and three 1" x 6" blocks for piping through 4". Submit shield schedule to demonstrate equivalency to pre-engineered/pre-manufactured product described above.
- F Wood blocks will not be accepted.

2.04 ACCESSORIES

- A All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of the systems to which they are applied.
- B Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.
- C Insulation bands to be 3/4 inch wide, constructed of aluminum or stainless steel. Minimum thickness to be .015 inch for aluminum and .010 inch for stainless steel.
- D Tack fasteners to be stainless steel ring grooved shank tacks.
- E Staples to be clinch style.
- F Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.
- G Finishing cement to be ASTM C449.
- H Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.
- I Bedding compounds to be non-shrinking and permanently flexible.
- J Vapor barrier coatings to be non-flammable, fire resistant, polymeric resin.
- K Fungicidal water base coating (Foster 40-20 or equal) to be compatible with vapor barrier coating.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install insulation, jackets and accessories in accordance with manufacturer instructions and under ambient temperatures and conditions recommended by manufacturer. Surfaces to be insulated must be clean and dry.
- B Do not insulate systems or equipment which is specified to be pressure tested or inspected, until testing, inspection and any necessary repairs have been successfully completed.
- C Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Cover and seal exposed fiberglass insulation when insulation is terminated, no raw fiberglass insulation is allowed. Provide neat and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates. Install with longitudinal joints facing wall or ceiling.
- D Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.
- E Use full-length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.
- F Insulation shall be continuous through sleeves and openings. Vapor barriers shall be maintained continuous through all penetrations.

- G Provide a complete vapor barrier for insulation on the following systems:
1. Cold water (potable and non-potable).
 2. Equipment piping with a surface temperature below 65 degrees F.

3.02 PIPING, VALVE, AND FITTING INSULATION

A GENERAL:

1. Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams and 2" tape on butt joints, firmly cemented with lap adhesive. Additionally secure with staples along seams and butt joints. Coat staples with vapor barrier mastic on systems requiring vapor barrier.
2. Water supply piping insulation shall be continuous throughout the building and installed adjacent to and within building walls to a point directly behind the fixture that is being supplied.
3. Install insulation continuous through pipe hangers and supports with hangers and supports on the exterior of insulation. Where a vapor barrier is not required, hangers and supports shall be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration. Where riser clamps are required to be attached directly to piping requiring vapor barrier, extend insulation and vapor barrier jacketing/coating around riser clamp.

B INSULATION INSERTS AND PIPE SHIELDS:

1. Provide insulation inserts and pipe shields at all hanger and support locations. Inserts shall be omitted on 3/4" and smaller copper piping provided 12" long 22 gauge pipe shields are used.

C FITTINGS AND VALVES:

1. Fittings, valves, unions, flanges, couplings and specialties shall be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Cover insulation with fabric reinforcing and mastic or where temperatures do not exceed 150 degrees, PVC fitting covers. Secure PVC fitting covers with tack fasteners and 1-1/2" band of mastic over ends, throat, seams or penetrations. On systems requiring vapor barrier, use vapor barrier mastic.

D PROTECTIVE JACKETS:

1. Provide a protective PVC jacket for the following insulated piping: in mechanical rooms.
2. Lap seams and joints a minimum of 2 inches and continuously seal with welding solvent recommended by jacket manufacturer. Lap slip joint ends 4" without fasteners where required to absorb expansion and contraction. For sections where vapor barrier is not required and jacket requires routine removal, tack fasteners shall be used.

E PIPE INSULATION SCHEDULE:

1. Provide insulation on new and existing remodeled piping as indicated in the following schedule:

Service	Insulation Types	Insulation Thickness by Pipe Size				
		1" and smaller	1-1/4" to 2"	2-1/2" to 4"	5" to 6"	8" and larger
Hot Water Supply	Rigid Fiberglass	1"	1"	1.5"	1.5"	1.5"
Hot Water Circulating	Rigid Fiberglass	1"	1"	1.5"		
Cold Water	Rigid Fiberglass	0.5"	0.5"	1"	1"	1"
Non-Potable Cold Water	Rigid Fiberglass *	0.5"	0.5"	1"		
Non-Potable Hot Water	Rigid Fiberglass *	1"	1"	1.5"		
Clearwater Waste	Rigid Fiberglass *	0.5"	0.5"	0.5"	0.5"	0.5"

* = Elastomeric & Phenolic types are acceptable

- F The following piping and fittings are not to be insulated:
1. Chrome plated exposed supplies and stops (except where specifically noted).
 2. Water hammer arrestors.
 3. Piping unions and flanges for systems not requiring a vapor barrier.

END OF SECTION 22 07 00

SECTION 22 10 13 FACILITY FUEL PIPING

PART 1 GENERAL

1.01 SCOPE

- A This section contains specifications for fuel pipe and fuel pipe fittings for this project. Included are the following topics:
1. PART 1 - GENERAL
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - i. Welder Qualifications.
 - j. Natural Gas Service.
 2. PART 2 - PRODUCTS
 - a. Natural Gas.
 - b. Vents and Relief Valves.
 - c. Unions and Flanges.
 3. PART 3 - EXECUTION
 - a. Preparation.
 - b. Erection.
 - c. Welded Pipe Joints.
 - d. Threaded Pipe Joints.
 - e. Natural Gas.
 - f. Vents and Relief Valves.
 - g. Unions and Flanges.
 - h. Piping System Leak Tests.
 4. APPENDIX.
 - a. Piping System Test Report.

1.02 RELATED WORK

- A Section 22 05 14 - Plumbing Specialties.
B Section 22 05 23 - General-Duty Valves for Plumbing Piping.
C Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
D Section 22 07 00 - Plumbing Insulation.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ANSI B16.3 Malleable Iron Threaded Fittings.
B ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

- C ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- D ANSI B31.9 Pipe Material Requirements.

1.05 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.

1.06 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.
- C TYPE E OR S STEEL PIPE:
 - 1. Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stenciled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.

1.07 QUALITY ASSURANCE

- A Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.
- B Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.08 DELIVERY, STORAGE, AND HANDLING

- A Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place.
- C Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D Storage and protection methods must allow inspection to verify products.

1.09 DESIGN CRITERIA

- A Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.
- B Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.
- C Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in occupied spaces and ventilation plenum spaces, including plenum ceilings.
- D Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- E Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

1.10 WELDER QUALIFICATIONS

- A Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section IX of the ASME Boiler and Pressure Vessel Code and/or the National Certified Pipe Welding Bureau.

- B Before any polyethylene fusion welding is performed, Contractor to submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285.
- C The Engineer or Owner reserves the right to test the work of any welder employed on the project, at the Contractor's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project.

1.11 NATURAL GAS SERVICE

- A This Contractor shall coordinate the size of the existing meter with the utility for providing a new meter with a capacity for the load.

PART 2 PRODUCTS

2.01 NATURAL GAS

- A 2" and Smaller: ASTM A53, type E or S, standard weight (schedule 40) black steel pipe with ASTM A197/ANSI B16.3 class 150 black malleable iron threaded fittings or ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.
- B 2-1/2" and Larger: ASTM A53, type E or S, standard weight black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

2.02 VENTS AND RELIEF VALVES

- A Use pipe and pipe fittings as specified for the system to which the relief valve or vent is connected.

2.03 UNIONS AND FLANGES

- A 2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.
- B 2-1/2" and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

PART 3 EXECUTION

3.01 PREPARATION

- A Remove all foreign material from interior and exterior of pipe and fittings.

3.02 ERECTION

- A Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- B Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- C Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.
- D "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

- E Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
- F Install all valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

3.03 WELDED PIPE JOINTS

- A Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.
- B Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

3.04 THREADED PIPE JOINTS

- A Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.05 NATURAL GAS

- A Pitch horizontal piping down 1" in 60 feet in the direction of flow. Install a 4" minimum depth dirt leg at the bottom of each vertical run and at each appliance. When installing mains and branches, cap gas tight each tee or pipe end which will not be immediately extended. All branch connections to the main shall be from the top or side of the main. Teflon tape is acceptable for use on natural gas lines.
- B Do not install gas pipe in a ventilation air plenum.
- C If an above ground vent terminates in an area subject to snow accumulation, terminate the line at least five feet above grade.
- D Install a shut off valve at each appliance. Provide a valve connection at the main for equipment and appliances furnished by others.
- E Piping through a roof shall be run through an approved roof penetration with flashing and counter flashing.
- F Each gas pressure reducing valve vent and relief valve vent shall be run separately to a point outside of the building, terminated with a screened vent cap, and located according to gas utility regulations.
- G Clean all welded piping before all regulators and control valves. Test by placing target cloth over piping and blow with compressed air. Clean piping until target cloth is clean and free of debris.

3.06 VENTS AND RELIEF VALVES

- A Install vent and relief valve discharge lines as indicated on the drawings, as detailed, and as specified for each specific valve or piping specialty item. In no event is a termination to occur less than six feet above a roof line.

3.07 UNIONS AND FLANGES

- A Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

3.08 PIPING SYSTEM LEAK TESTS

- A Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.
- B Provide all piping, fittings, blind flanges, and equipment to perform the testing.

- C Conduct pressure test with test medium of air or water unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the Division's representative. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.
- D Do not insulate pipe until it has been successfully tested.
- E For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- F For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.
- G Measure natural gas system test pressure with a water manometer or an equivalent device calibrated in increments not greater than 0.1 inch water column. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during the test period.

<u>System</u>	<u>PressureMedium</u>	<u>Duration</u>
Natural gas	100 psig Air	24 hr

- H All pressure tests are to be documented on a form included in this specification.
- I On piping that cannot be tested because of connection to an active line, provide temporary blind flanges and hydrostatically test new section of piping. After completion of test, remove temporary flanges and make final connections to piping. Die penetrate test pass weld or x-ray the piping that was not hydrostatically tested up to the active system.

END OF SECTION 22 10 13

PIPING SYSTEM TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____ Project No: _____

Contractor: _____

- HVAC Refrigeration Controls
- Power Plant Plumbing Fire Sprinkler

Test Medium: Air Water Other _____

Test performed per specification section No. _____

Specified Test Duration _____ Hours Specified Test Pressure _____ PSIG

System Identification: _____

Describe Location: _____

Test Date: _____

Start Test Time: _____ **Initial Pressure:** _____ PSIG

Stop Test Time: _____ **Final Pressure:** _____ PSIG

Tested By: _____

Witnessed By: _____

Title: _____

Title: _____

Signed: _____

Signed: _____

Date: _____

Date: _____

Comments: _____

SECTION 22 11 00
FACILITY WATER DISTRIBUTION

PART 1 GENERAL

1.01 SCOPE

- A This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - i. Welder Qualifications.
 2. PART 2 – PRODUCTS.
 - a. Domestic Water.
 - b. Dielectric Unions and Flanges.
 - c. Unions and Flanges.
 3. PART 3 – EXECUTION.
 - a. General.
 - b. Preparation.
 - c. Erection.
 - d. Copper Pipe Joints.
 - e. Welded Pipe Joints.
 - f. Threaded Pipe Joints.
 - g. Domestic Water.
 - h. Dielectric Unions and Flanges.
 - i. Unions and Flanges.
 - j. Piping System Leak Tests.
 4. APPENDIX.
 - a. Piping System Test Report.

1.02 RELATED WORK

- A Section 22 05 14 - Plumbing Specialties.
B Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ANSI A21.4.
B ANSI A21.11.
C ANSI A21.51.

- D ANSI B16.3 - Malleable Iron Threaded Fittings.
- E ANSI B16.4 - Cast Iron Threaded Fittings.
- F ANSI B16.5 - Pipe Flanges and Flanged Fittings.
- G ANSI B16.22 - Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
- H ANSI B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.
- I ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- J ASTM A105 - Forgings, Carbon Steel, for Piping Components.
- K ASTM A126 - Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
- L ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- M ASTM B32 - Solder Metal.
- N ASTM B88 - Seamless Copper Water Tube.
- O ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- P ASTM B813 - Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
- Q ASTM D1785 - Poly Vinyl Chloride (PVC) Plastic Pipe.
- R ASTM D2241 - Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
- S ASTM D2464 - Threaded Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
- T ASTM D2466 - Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
- U ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
- V ASTM D2564 - Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
- W ASTM D2657 - Heat Fusion Joining of Polyolefin Pipe and Fittings.
- X ASTM D2774 - Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
- Y ASTM D2855 - Making Solvent Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
- Z ASTM D313 - Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- AA ASTM D3222 - Unmodified Poly Vinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials.
- BB ASTM D4101 - Propylene Plastic Injection and Extrusion Materials.
- CC ASTM F437 - Threaded Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80.
- DD ASTM F438 - Socket Type Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40.
- EE ASTM F441 - Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80.
- FF ASTM F493 - Solvent Cements for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe and Fittings.
- GG ASTM F656 - Primers for Use in Solvent Cement Joints of Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
- HH AWS A5.8 - Brazing Filler Metal.
- II AWWA C104 - Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water.
- JJ AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water.
- KK AWWA C110 - Ductile Iron and Gray Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids.
- LL AWWA C111 - Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
- MMAWWA C151- Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
- NN AWWA C153 - Ductile Iron Compact Fittings, 3 In. Through 48 In., for Water and Other Liquids.
- OO AWWA C600 - Installation of Ductile Iron Water Mains and Their Appurtenances.
- PP AWWA C651 - Disinfecting Water Mains.
- QQ AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution.

1.05 SHOP DRAWINGS

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

- B Schedule from the Contractor indicating the ASTM, AWWA or CISPI specification number of the pipe being proposed along with its type and grade if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.
- C Statement from manufacturer on his letterhead that pipe furnished meets the ASTM, AWWA or CISPI specification contained in this section.

1.06 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B Order all copper, cast iron, steel, PVC and polyethylene pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.
- C Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.07 DELIVERY, STORAGE, AND HANDLING

- A Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D Storage and protection methods must allow inspection to verify products.

1.08 DESIGN CRITERIA

- A Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM, AWWA or CISPI specifications as listed in this specification.
- B Construct all piping for the highest pressures and temperatures in the respective system.
- C Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.
- D Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- E Where ASTM A53 type F pipe is specified, grade A type E or S, or grade B type E or S may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- F Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper copper tubing may be substituted at Contractor's option.

1.09 WELDER QUALIFICATIONS

- A Welding procedures, welders, and welding operators for all building service piping to be in accordance with certified welding procedures of the National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing. Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.
- B Before any polyethylene fusion welding is performed, Contractor to submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285.

- C The Engineer reserves the right to test the work of any welder employed on the project, at the Owner's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project and all defective welds replaced.

PART 2 PRODUCTS

2.01 DOMESTIC WATER

- A ABOVE GROUND:
 - 1. Type L copper water tube, H (drawn) temper, ASTM B88; wrought copper pressure fittings, ASME B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP.
 - a. Alternative Fittings: Mechanical press sealed fittings. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18, ASME B16.22 or ASME B16.51 and performance criteria of IAPMO PS 117. Fittings shall be NSF/ANSI 61 approved and utilize EPDM sealing elements. Sealing elements shall be factory installed.
 - 1) Manufacturers:
 - a) Viega Propress: www.viega.us.
 - b) Mueller Industries Streamline PRS: www.muellerindustries.com.
 - c) Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B UNDERGROUND TO INTERIOR BUILDING ENTRANCE PIPING 3" AND LARGER:
 - 1. Ductile iron as specified above with factory threaded and machined flanges.
- C THRUST RESTRAINTS FOR UNDERGROUND PIPING:
 - 1. Asphaltic or epoxy coated ductile iron follower gland mechanical joint restraint with gripping wedge restraints and torque limiting twist-off nuts around the pipe circumference, low alloy steel T-bolts and UL listing or Factory Mutual approval. For PVC pipe joint bells, use epoxy or primer coated ductile iron bell and serrated ring restraints or gripping wedge restraints and torque limiting twist-off nuts around the pipe circumference with low alloy steel tie bolts. Restraint to have minimum pressure rating and safety factor equal to or greater than pressure rating and safety factor of pipe and be designed specifically for the pipe material it's applied on.

2.02 DIELECTRIC UNIONS AND FLANGES

- A Manufacturers:
 - 1. Watts Regulator Company: www.wattsregulator.com.
 - 2. Lochinvar: www.lochinvar.com.
 - 3. Wilkins: www.zurn.com.
 - 4. EPCO Sales, Inc.: www.epcinc.com.
- B Dielectric unions 2" and smaller; dielectric flanges 2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets, having a pressure rating of not less than 175 psig at 180 degrees.

2.03 UNIONS AND FLANGES

- A Unions, flanges and gasket materials to have a pressure rating of not less than 150 psig at 180 degrees. Gasket material for flanges and flanged fittings shall be teflon type. Treated paper gaskets are not acceptable.
- B 2" AND SMALLER STEEL:
 - 1. ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping.

- C 2" AND SMALLER COPPER:
 - 1. ANSI B16.18 cast bronze union coupling or ANSI B15.24 Class 150 cast bronze flanges.
- D 2-1/2" AND LARGER STEEL:
 - 1. ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding neck, or slip-on pattern on black steel and threaded only on galvanized steel. Use raised face flanges ANSI B16.5 for mating with other raised face flanges or equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face teflon gaskets for mating with other flat face flanges on equipment. Gaskets shall be teflon type.
- E 2-1/2" AND LARGER COPPER:
 - 1. ANSI B15.24 Class 150 cast bronze flanges with full face teflon gaskets.

PART 3 EXECUTION

3.01 GENERAL

- A Install pipe and fittings in accordance with reference standards, manufacturers recommendations and recognized industry practices.

3.02 PREPARATION

- A Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.03 ERECTION

- A Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- B Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.
- C Install underground warning tape 6"-12" below finished grade above all exterior below ground piping. Where existing underground warning tape is encountered, repair and replace.
- D Maintain piping in clean condition internally during construction.
- E Provide clearance for installation of insulation, access to valves and piping specialties.
- F Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- G Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
- H Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to all equipment, fixtures and systems installed by others where same requires the piping services indicated in this section.

3.04 COPPER PIPE JOINTS

- A Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with metal brush, emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux and assemble joint to socket stop. Apply flame to fitting until solder melts when placed at joint. Remove flame and feed solder into joint until full penetration of cup and ring of solder appears. Wipe excess solder and flux from joint.

3.05 WELDED PIPE JOINTS

- A Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

3.06 THREADED PIPE JOINTS

- A Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.07 DOMESTIC WATER

- A Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.
- B Install exterior water piping below predicted frost level in accordance with COMM Table 82.30-6, but in no case less than 6' bury depth to top of pipe. Maintain minimum of 8' horizontal distance between 2-1/2" and larger water piping and sanitary sewer piping. Maintain minimum of 30" horizontal and 12" vertical distance, water on top, between 2" and smaller water piping and sanitary sewer piping. Where water piping crosses a sanitary sewer, provide minimum 18" vertical clearance and waterproof PVC water pipe sleeve (reference sanitary sewer materials) sealed at both ends for distance of 10' from sewer in both directions.
- C Provide thrust restraints for 3" and larger exterior water piping joints, hydrants, caps, plugs, fittings and bends of 22-1/2 degrees or more. Field apply continuous anti-corrosion coating to rodded restraint components. Protect mechanical joints, nuts and bolts from concrete cover. Cover with 8 mil sheet or tube polyethylene material sleeve.
- D Install interior water piping with drain valves where indicated and at low points of system to allow complete drainage. Install shutoff valves where indicated and at the base of risers to allow isolation of portions of system for repair. Do not install water piping within exterior walls.
- E Prior to use, isolate and fill system with potable water. Allow to stand 24 hours. Flush each outlet proceeding from the service entrance to the furthest outlet for minimum of 1 minute and until water appears clear. Fill system with a solution of water and chlorine containing at least 50 parts per million of chlorine and allow to stand for 24 hours. Alternately a solution containing at least 200 parts per million of chlorine may be used and allowed to stand for 3 hours. Flush system with potable water until chlorine concentration is no higher than source water level.
- F Wait 24 hours after final flushing. Take samples of water for lab testing. The number and location of samples shall be representative of the system size and configuration and are subject to approval by Engineer. Test shall show the absence of coliform bacteria. If test fails, repeat disinfection and testing procedures until no coliform bacteria are detected. Submit test report indicating date and time of test along with test results.

3.08 DIELECTRIC UNIONS AND FLANGES

- A Install dielectric unions or flanges at each point where a copper-to-steel pipe connection is required in domestic water systems.

3.09 UNIONS AND FLANGES

- A Install a union or flange at each connection to each piece of equipment and at other items which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

3.10 PIPING SYSTEM LEAK TESTS

- A Isolate or remove components from system which are not rated for test pressure. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.
- B If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Backfill underground water mains prior to testing with the exception of thrust restrained valves which may be exposed to isolate potential leaks.
- C For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- D Inspect system for leaks. Where leaks occur, repair the area with new materials and repeat the test; caulking will not be acceptable.
- E Entire test must be witnessed by the Owner’s representative. All pressure tests are to be documented on forms to be provided to the Contractor.

System	Test Medium	Initial Test _____		Final Test _____	
		Pressure	Duration	Pressure	Duration
*Below Ground - Domestic Water	Water	N/A		200 psig	2 hr
Above Ground - Domestic Water	Water	N/A		100 psig	8 hr
Above Ground - Non-potable Water	Water	N/A		100 psig	8 hr
Below Ground - Non-potable Water	Water	N/A		100 psig	8 hr

* Leakage on exterior mains 3" and larger may not exceed leakage calculated as follows:

$$\text{GPH Allowable Leakage} = \frac{(\text{Feet of Pipe}) (\text{Inches Dia. of Pipe}) (\text{Test Pressure})^5}{133,200}$$

END OF SECTION 22 11 00

PIPING SYSTEM TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____ Project No: _____

Contractor: _____

- Plumbing Fire Sprinkler

Test Medium: Air Water Other _____

Test performed per specification section No. _____

Specified Test Duration _____ Hours Specified Test Pressure _____ PSIG

System Identification: _____

Describe Location: _____

<i>Test Date:</i> _____	
<i>Start Test Time:</i> _____	<i>Initial Pressure:</i> _____ PSIG
<i>Stop Test Time:</i> _____	<i>Final Pressure:</i> _____ PSIG

Tested By: _____

Witnessed By: _____

Title: _____

Title: _____

Signed: _____

Signed: _____

Date: _____

Date: _____

Comments: _____

SECTION 22 13 00
FACILITY SANITARY SEWERAGE

PART 1 GENERAL

1.01 SCOPE

- A This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - i. Welder Qualifications.
 2. PART 2 – PRODUCTS.
 - a. Sanitary Waste and Vent.
 3. PART 3 – EXECUTION.
 - a. General.
 - b. Preparation.
 - c. Erection.
 - d. Welded Pipe Joints.
 - e. Threaded Pipe Joints.
 - f. Solvent Welded Pipe Joints.
 - g. Sanitary Waste and Vent.
 - h. Piping System Leak Tests.

1.02 RELATED WORK

- A Section 22 05 14 - Plumbing Specialties.
B Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ANSI A21.4.
B ANSI A21.11.
C ANSI A21.51.
D ANSI B16.3 Malleable Iron Threaded Fittings.
E ANSI B16.4 Cast Iron Threaded Fittings.
F ANSI B16.5 Pipe Flanges and Flanged Fittings.
G ANSI B16.22 Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
H ANSI B16.29 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.
I ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

J	ASTM A74	Cast Iron Soil Pipe and Fittings.
K	ASTM A105	Forgings, Carbon Steel, for Piping Components.
L	ASTM A126	Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
M	ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
N	ASTM A861	High Silicon Iron Pipe and Fittings.
O	ASTM A888	Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
P	ASTM B32	Solder Metal.
Q	ASTM B306	Copper Drainage Tube (DWV).
R	ASTM B813	Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
S	ASTM C76	Reinforced Concrete Culvert, Storm Drain and Sanitary Pipe.
T	ASTM C564	Standard Specifications for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
U	ASTM C1540	Standard Specifications for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
V	ASTM D1785	Poly Vinyl Chloride (PVC) Plastic Pipe.
W	ASTM D2241	Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
X	ASTM D2466	Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
Y	ASTM D2564	Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
Z	ASTM D2665	Poly Vinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
AA	ASTM D2729	Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
BB	ASTM D2774	Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
CC	ASTM D2855	Making Solvent Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
DD	ASTM D3034	Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
EE	ASTM D3139	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
FF	ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
GG	ASTM D3222	Unmodified Poly Vinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials.
HH	ASTM D3311	Drain, Waste and Vent (DWV) Plastic Fitting Patterns.
II	AWS A5.8	Brazing Filler Metal.
JJ	CISPI 301	Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
KK	CISPI 310	Couplings For Use In Connection With Hubless Cast Iron Soil Pipe And Fittings For Sanitary And Storm Drain, Waste And Vent Piping Applications.

1.05 SHOP DRAWINGS

- A Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B Schedule from the Contractor indicating the ASTM, or CISPI specification number of the pipe being proposed along with its type and grade if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.
- C Statement from manufacturer on his letterhead that pipe furnished meets the ASTM, or CISPI specification contained in this section.

1.06 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B Order all copper, cast iron, steel, PVC and polyethylene pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.
- C Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.07 DELIVERY, STORAGE, AND HANDLING

- A Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D Storage and protection methods must allow inspection to verify products.

1.08 DESIGN CRITERIA

- A Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM, or CISPI specifications as listed in this specification.
- B Construct all piping for the highest pressures and temperatures in the respective system.
- C Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.
- D Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- E Where ASTM A53 type F pipe is specified, grade A type E or S, or grade B type E or S may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- F Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper copper tubing may be substituted at Contractor's option.

1.09 WELDER QUALIFICATIONS

- A Welding procedures, welders, and welding operators for all building service piping to be in accordance with certified welding procedures of the National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing. Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.
- B Before any polyethylene fusion welding is performed, Contractor to submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285.
- C The Engineer reserves the right to test the work of any welder employed on the project, at the Contractor's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project and all defective welds replaced.

PART 2 PRODUCTS

2.01 SANITARY WASTE AND VENT

A INTERIOR ABOVE GROUND:

1. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

B INTERIOR BELOW GROUND:

1. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

PART 3 EXECUTION

3.01 GENERAL

- A Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

3.02 PREPARATION

- A Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.03 ERECTION

- A Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- B Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.
- C Install underground warning tape 6"-12" below finished grade above all exterior below ground piping. Where existing underground warning tape is encountered, repair and replace.
- D Maintain piping in clean condition internally during construction.
- E Provide clearance for installation of insulation, access to valves and piping specialties.
- F Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- G Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.
- H Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to all equipment, fixtures and systems installed by others where same requires the piping services indicated in this section.

3.04 WELDED PIPE JOINTS

- A Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

3.05 THREADED PIPE JOINTS

- A Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.06 SOLVENT WELDED PIPE JOINTS

- A Install in accordance with ASTM D2855 "Making Solvent Cemented Joints with PVC Pipe and Fittings". Saw cut piping square and smooth. Tube cutters may be used if they are fitted with wheels designed for use with PVC/CPVC pipe that do not leave a raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and scratches. Bevel ends 10-15 degrees and deburr interior. Remove dust, drips, moisture, grease and other superfluous materials from pipe interior and exterior. Check dry fit of pipe and fittings. Reject materials which are out of round or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.
- B Maintain pipe, fittings, primer and cement between 40 and 100 degrees during application and curing. Apply primer and solvent using separate daubers (3" and smaller piping only) or clean natural bristle brushes about 1/2 the size of the pipe diameter. Apply primer to the fitting socket and pipe surface with a scrubbing motion. Check for penetration and reapply as needed to dissolve surface to a depth of 4-5 thousandths. Apply solvent cement to the fitting socket and pipe in an amount greater than needed to fill any gap. While both surfaces are wet, insert pipe into socket fitting with a quarter turn to the bottom of the socket. Solvent cement application and insertion must be completed in less than 1 minute. Minimum of 2 installers is required on piping 4" and larger. Hold joint for 30 seconds or until set. Reference manufacturer's recommendations for initial set time before handling and for full curing time before pressure testing. Cold weather solvent/cement may be utilized only under unusual circumstances and when specifically approved by the Owner.

3.07 SANITARY WASTE AND VENT

- A Verify invert elevations and building elevations prior to installation. Install exterior piping pitched to drain at indicated elevations and slope. Install interior piping pitched to drain at minimum slope of 1/4" per foot where possible and in no case less than 1/8" per foot for piping 3" and larger.
- B Install exterior piping below predicted frost level and not less than 5' bury depth to top of pipe wherever possible. Where piping is located above predicted frost level, provide frost protection in accordance with SPS 382.30(11)(c).
- C Flush piping inlets (floor drains, hub drains, mop basins, fixtures, etc.) with high flow of water at completion of project to demonstrate full flow capacity. Remove blockages and make necessary repairs where flow is found to be impeded.

3.08 PIPING SYSTEM LEAK TESTS

- A Isolate or remove components from system which are not rated for test pressure. Perform final testing for medical and lab gas with all system components in place. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.
- B If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Backfill underground water mains prior to testing with the exception of thrust restrained valves which may be exposed to isolate potential leaks.
- C For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- D For air or nitrogen tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during the test period.

- E Inspect system for leaks. Where leaks occur, repair the area with new materials and repeat the test; caulking will not be acceptable.
- F Entire test must be witnessed by the Owner's representative. All pressure tests are to be documented on forms to be provided to the Contractor.

<u>System</u>	<u>Test Medium</u>	<u>Initial Test</u>		<u>Final Test</u>	
		<u>Pressure</u>	<u>Duration</u>	<u>Pressure</u>	<u>Duration</u>
Sanitary Waste & Vent	Water	N/A		10' water	2 hr
Pressurized Sanitary Waste & Vent	Water	N/A		100 psig	2 hr

END OF SECTION 22 13 00

SECTION 22 30 00 PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for water heaters, water softeners, pumps and other equipment used for plumbing applications. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Documents.
 - c. Reference.
 - d. Quality Assurance.
 - e. Shop Drawings.
 - f. Operation and Maintenance Data.
 2. PART 2 – PRODUCTS.
 - a. Electric Water Heater.
 - b. In-Line System Lubricated Centrifugal Pumps.
 - c. Expansion Tanks.
 3. PART 3 – EXECUTION.
 - a. Installation.

1.02 RELATED DOCUMENTS

- A Section 22 05 15 - Piping Specialties.
B Section 22 05 23 - General-Duty Valves for Plumbing Piping.
C Section 22 07 00 - Plumbing Insulation.
D Division 26 - Electrical.

1.03 REFERENCE

- A Applicable provisions of Division 1 shall govern work under this section.

1.04 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
B Plumbing products requiring approval by the State of Wisconsin Dept. of Safety and Professional Services must be approved or have pending approval at the time of shop drawing submission.

1.05 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
B Include data concerning dimensions, capacities, materials of construction, ratings, certifications, weights, pump curves with net positive suction head requirements, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

1.06 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 - Closeout Submittals.

PART 2 PRODUCTS

2.01 ELECTRIC WATER HEATER

- A Manufacturers:
1. A.O. Smith: www.hotwater.com.
 2. Bradford White: www.bradfordwhite.com.
 3. State: www.waterheaters.com.

- B Type: Electric storage domestic water heater. Design to be UL listed with 3 year commercial use tank warranty and 3 year parts warranty.
Efficiency: 20 gallons and ≤ 12 kW 0.94 Minimum Energy Factor
 ≥ 30 gallons and ≤ 12 kW 0.93 Minimum Energy Factor
- C Tank: Steel glass lined tank rated for 150 psig complete with removable magnesium anode rod, plastic diffuser type dip tube, inlet and outlet heat trap fittings, minimum R-20 polyurethane foam insulation, painted steel jacket, drain valve and temperature and pressure relief valve.
- D Elements: Dual 4500 watt heating elements to be replaceable threaded low watt density incoloy sheath with adjustable thermostat control, energy cutoff and wired for non-simultaneous operation.

2.02 IN-LINE SYSTEM LUBRICATED CENTRIFUGAL PUMPS

- A Manufacturer:
 - 1. Bell and Gossett: www.bellgossett.com.
 - 2. Grundfos: www.grundfos.com.
 - 3. Taco: www.taco-hvac.com.
- B Type: Horizontal single stage close coupled system lubricated in-line pumps, 125 psig maximum working pressure at operating temperature of 225°F continuous. The manufacturer shall certify all pump ratings. All pumps to operate without excessive noise or vibration.
- C Casing: Bronze or stainless steel; flanged suction and discharge connection.
- D Impeller: Bronze, stainless steel or thermoplastic, keyed to the shaft, single suction enclosed type, hydraulically and dynamically balanced.
- E Bearings: System lubricated carbon sleeve bearings.
- F Shaft: Stainless steel or ceramic.
- G Seal: Stainless steel can isolating rotor and stator.
- H Motor: Provide pump with impedance protected motor sized for non-overloading over the entire pump curve. Furnish each pump and motor with a nameplate giving the manufacturer's name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current.

2.03 EXPANSION TANKS

- A Manufacturer:
 - 1. Amtrol: www.amtrol.com.
 - 2. Bell and Gossett: www.bellgossett.com.
 - 3. Wessels: www.westank.com.
- B Vertical steel precharged hydro-pneumatic expansion tank, 125 psi ASME labeled construction, complete with replaceable flexible butyl rubber bladder, system connection fitting, Schrader type air charge fitting, steel base ring stand, factory prime and enamel painted exterior finish, ASME relief valve. Materials exposed to water to be NSF or FDA approved for potable water service.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install plumbing equipment where indicated in accordance with manufacturer's recommendations. Coordinate equipment location with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. Locate equipment and arrange plumbing piping to provide access space for servicing all components.
- B Set commercial water heater on concrete housekeeping pads. Adjust and level equipment.
- C Connect equipment to water and drain piping using unions or flanges and isolation valves.

- D Size temperature and relief valves per CSA ratings. Pipe temperature and pressure relief valves to floor drain or floor as indicated.
- E Startup and test equipment adjusting operating and safety controls for proper operation.
- F Lubricate pumps before startup. Adjust pumps for rated flow. Clean and blowdown strainers after 8 hours of operation.
- G Adjust compression tank precharge to scheduled minimum operating pressure prior to connecting to system.

END OF SECTION 22 30 00

INTENTIONALLY LEFT BLANK

SECTION 22 42 00
COMMERCIAL PLUMBING FIXTURES

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for plumbing fixtures, faucets and trim.
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Quality Assurance.
 - e. Shop Drawings.
 - f. Operation and Maintenance Data.
 - g. Design Criteria.
 - h. Energy Efficiency Requirements.
 - 2. PART 2 – PRODUCTS.
 - a. Plumbing Fixtures.
 - 3. PART 3 – EXECUTION.
 - a. Installation.

1.02 RELATED WORK

- A Section 22 05 14 - Plumbing Specialties.
- B Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
- C Section 22 11 00 - Facility Water Distribution.
- D Section 22 13 00 - Facility Sanitary Sewerage.

1.03 REFERENCE

- A Applicable provisions of Division 1 shall govern work under this section.

1.04 QUALITY ASSURANCE

- A Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B Plumbing products requiring approval by the State of Wisconsin Dept. of Safety and Professional Services must be approved or have pending approval at the time of shop drawing submission.

1.05 SHOP DRAWINGS

- A Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B Include data concerning sizes, utility sizes, rough in-dimensions, capacities, materials of construction, ratings, weights, trim, finishes, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

1.06 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 - Closeout Submittals.

1.07 DESIGN CRITERIA

- A ANSI A112.6.1M-88 - Supports for Off-the Floor Plumbing Fixtures for Public Use.
- B ANSI A112.18.1-94 - Finished and Rough Brass Plumbing Fixture Fittings.
- C ANSI A112.19.1-90 - Enameled Cast Iron Plumbing Fixtures.
- D ANSI A112.19.2M-82 - Vitreous China Plumbing Fixtures.
- E ANSI A112.19.5-79 (R1990) - Trim for Water Closet Bowls, Tanks and Urinals.
- F ANSI Z124.1-87 - Plastic Bathtub Units.

- G ANSI Z124.2-87 - Plastic Shower Receptors and Shower Stalls.
- H AHRI-1010-94 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- I ASSE 1011-93 - Hose Connection Vacuum Breakers.
- J ASSE 1014-90 - Handheld Showers.
- K ASSE 1035-93 - Laboratory Faucet Backflow Preventers.

1.08 ENERGY EFFICIENCY REQUIREMENTS

- A Plumbing fixtures must meet the following maximum water usage requirements which are based upon Federal Energy Management Program (FEMP) performance requirements.
 - 1. Lavatory Faucets, flow of 2 gpm or less and .25 gallon per cycle or less (based on inlet pressure of 60 p.s.i.).
 - 2. Showerheads, flow of 2.2 gpm or less (based on inlet pressure of 80 p.s.i.).
 - 3. Urinal Flush Valves, 1.0 gallon per flush or less.
 - 4. Water Closet Flush Valves, 1.6 gallon per flush or less.

PART 2 PRODUCTS

2.01 REFER TO SHEET P001 FOR MORE INFORMATION REGARDING PLUMBING FIXTURES AND EQUIPMENT.

2.02 PLUMBING FIXTURES

- A Manufacturers: Fixture descriptions establish fixture type, quality, materials, features and size. Products of the following manufacturers determined to be equal by the Engineer will be accepted.
 - 1. Water Closets:
 - a. American Standard: www.americanstandard-us.com.
 - b. Kohler: www.kohler.com.
 - 2. Water Closet Seats:
 - a. Bemis: www.bemisseats.com.
 - b. Beneke: www.unique-toilet-seat.com.
 - c. Centoco: www.centoco.com.
 - d. Olsonite Sperzel: www.olsonite.com.
 - 3. Urinals:
 - a. American Standard: www.americanstandard-us.com.
 - b. Kohler; www.kohler.com.
 - 4. Lavatories:
 - a. American Standard: www.americanstandard-us.com.
 - b. Kohler: www.kohler.com.
 - 5. Faucets:
 - a. Chicago Faucet: www.chicagofaucet.com.
 - b. Kohler: www.kohler.com.
 - c. Speakman: www.speakmancompany.com.
 - d. Symmons: www.symmons.com.
 - 6. Drains:
 - a. Chicago Faucet: www.chicagofaucet.com.
 - b. Engineered Brass Co.: www.justmfg.com.
 - c. Kohler: www.kohler.com.
 - d. McGuire: www.mcguiremfg.com.
 - 7. Stops and Supplies (Heavy Duty Type Only):
 - a. Chicago Faucet Co.: www.chicagofaucet.com.

- b. T&S Brass: www.tsbrass.com.
- c. McGuire: www.mcguiremfg.com.
- 8. Flush Valves:
 - a. Coyne & Delany: www.delanyproducts.com.
 - b. Sloan Royal: www.sloanvalve.com.
 - c. Zurn AV: www.zurnproducts.com.
- 9. Traps (17 gauge Min.):
 - a. Kohler: www.kohler.com.
 - b. McGuire: www.mcguiremfg.com.
 - c. Dearborn: www.dearbornbrass.com.
 - d. Engineered Brass Co.: www.justmfg.com.
- 10. Carriers and Supports:
 - a. Josam: www.josam.com.
 - b. Smith: www.jrsmith.com.
 - c. Wade: www.wadedrains.com.
 - d. Watts Drainage: www.watts.com.
 - e. Zurn: www.zurn.com.
- 11. Sinks:
 - a. American Standard: www.americanstandard-us.com.
 - b. Elkay: www.elkay.com.
 - c. Just: www.justmfg.com.
 - d. Kohler: www.kohler.com.
- 12. Mop Basins:
 - a. Fiat: www.fiat.ca.
 - b. Mustee: www.mustee.com.
- 13. Electric Water Coolers:
 - a. Elkay: www.elkay.com.
 - b. Halsey Taylor: www.halseytaylor.com.
 - c. Haws: www.hawsco.com.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install plumbing fixtures in accordance with manufacturer's instructions. Set level and plumb. Secure in place to counters, floors and walls providing solid bearing and secure mounting. Bolt fixture carriers to floor and wall. Secure rough-in fixture piping to prevent movement of exposed piping.
- B Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing.
- C Install barrier free fixtures in compliance with IBC 1108 and 3408, COMM 52, 69 and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27" above floor to avoid contact by wheelchair users.
- D Provide unions at water connections to drinking fountains and electric water coolers.
- E Each fixture shall have a stop valve installation to control the fixture. Stop valves shall be heavy duty type with brass stems and screwed or sweat inlet connections. Compression type inlets are not acceptable.
- F Cover pipe penetrations with escutcheons. Exposed traps, stops, piping and escutcheons to be chrome plated brass, same items in concealed locations may be of rough brass finish.

- G Set floor mounted water closets, floor mounted service sinks; counter mounted lavatories and sinks; lavatories and sink faucets and drains with full setting bed of flexible non-staining plumber's putty. Cover exposed water closet bolts with bolt covers.
- H Set mop basins to floor and wall with grout or silicone sealant.
- I Seal openings between walls, floors and fixtures with mildew-resistant silicone sealant same color as fixture.
- J Test fixtures to demonstrate proper operation. Replace malfunctioning units or components. Adjust valves for intended water flow rate to fixtures without splashing, noise or overflow. Adjust self-closing lavatory faucets to 15 second cycle. Adjust shower valve temperature limit stops to 110 degree maximum outlet temperature.
- K Protect fixtures during construction. At completion clean plumbing fixtures and trim using manufacturer's recommended cleaning methods and materials.
- L Foodservice Equipment: Provide rough-in piping, traps, tailpieces, indirect waste lines and make final and necessary connections for foodservice equipment. Install faucets, spray units, drains, lever drains, vacuum breakers, solenoid valves, check valves, flow control valves, water inlet fittings, filters, strainers, pressure reducing valves and gas valves furnished by foodservice equipment contractor. Provide condensate drain piping from cooler and freezer evaporators. Make all final and necessary plumbing connections.
- M Existing Fixtures: Where existing fixtures and fittings are indicated to be reused or relocated, this Contractor is responsible for documenting condition prior to construction and for damages incurred during construction.

END OF SECTION 22 42 00

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
- B Section 07 84 00 - Firestopping.
- C Section 23 05 13 - Common Motor Requirements for HVAC.
- D Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
- E Section 23 33 00 - Air Duct Accessories.

1.02 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.03 REFERENCE STANDARDS

- A Abbreviations of standards organizations referenced in other sections are as follows:
 - 1. AABC Associated Air Balance Council.
 - 2. ABMA American Boiler Manufacturers Association.
 - 3. ADC Air Diffusion Council.
 - 4. AGA American Gas Association.
 - 5. AMCA Air Movement and Control Association.
 - 6. ANSI American National Standards Institute.
 - 7. AHRI Air-Conditioning, Heating and Refrigeration Institute.
 - 8. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers.
 - 9. ASME American Society of Mechanical Engineers.
 - 10. ASTM American Society for Testing and Materials.
 - 11. AWWA American Water Works Association.
 - 12. AWS American Welding Society.
 - 13. CGA Compressed Gas Association.
 - 14. CTI Cooling Tower Institute.
 - 15. EPA Environmental Protection Agency.
 - 16. GAMA Gas Appliance Manufacturers Association.
 - 17. IEEE Institute of Electrical and Electronics Engineers.
 - 18. ISA Instrument Society of America.
 - 19. MCA Mechanical Contractors Association.
 - 20. MICA Midwest Insulation Contractors Association.
 - 21. MSS Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
 - 22. NBS National Bureau of Standards.
 - 23. NEBB National Environmental Balancing Bureau.
 - 24. NEC National Electric Code.
 - 25. NEMA National Electrical Manufacturers Association.
 - 26. NFPA National Fire Protection Association.
 - 27. SMACNA Sheet Metal and Air Conditioning Contractors' National Association. Inc.

- 28. UL Underwriters Laboratories Inc.
- 29. ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- 30. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- 31. UL1479 Fire Tests of Through-Penetration Firestops.
- 32. UL723 Surface Burning Characteristics of Building Materials.

1.04 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.
- B Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the performance from the system into which these items are placed. This may include changes found necessary during the testing, adjusting, and balancing phase of the project.

1.05 PROTECTION OF FINISHED SURFACES

- A Refer to Division 1, General Requirements.
- B Furnish one can of touch-up paint for each different color factory finish which is to be the final finished surface of the product. Deliver touch-up paint with other "loose and detachable parts" as covered in the General Requirements.

1.06 SLEEVES AND OPENINGS

- A Refer to Division 1, General Requirements.

1.07 SEALING AND FIRESTOPPING

- A Sealing and firestopping of sleeves/openings between ductwork, piping, etc. and the sleeve, structural or partition opening shall be the responsibility of the Contractor whose work penetrates the opening. The Contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.
- B Firestopping shall be UL listed and labeled for the actual application.
- C Refer to Section 07 84 00 - Firestopping.

1.08 SUBMITTALS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Submittals must be reviewed and approved by Engineer and Owner.
- C Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents.
- D Before submitting electrically powered equipment, verify that the electrical power and control requirements for the equipment are in agreement with the motor starter schedule on the electrical drawings. Include a statement on the shop drawing transmittal to the Engineer that the equipment submitted, and the motor starter schedule is in agreement or indicate any discrepancies. See related comments in Section 23 05 13 - Common Motor Requirements for HVAC Equipment in Part 1 under Electrical Coordination.
- E Include wiring diagrams of electrically powered equipment.

1.09 OFF SITE STORAGE

- A Prior approval by Owner and the Engineer will be needed. The Contractor shall carry insurance for full value, with Owner as beneficiary for consideration of offsite materials storage.
- B Generally, ductwork, metal for making ductwork, duct lining, sleeves, pipe/pipe fittings and similar rough in material will not be accepted for offsite storage. For material that can be stored off site, no material will be accepted for offsite storage unless shop drawings for that material have been approved.

1.10 CERTIFICATES AND INSPECTIONS

- A Refer also to the General Conditions for Certificates and Inspections.

1.11 OPERATING AND MAINTENANCE INSTRUCTIONS

- A Refer to Division 1, General Requirements.
- B Assemble material in three ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
 - 1. Copies of all approved shop drawings.
 - 2. Manufacturer's wiring diagrams for electrically powered equipment.
 - 3. Records of tests performed to certify compliance with system requirements.
 - 4. Certificates of inspection by regulatory agencies.
 - 5. Temperature control record drawings and control sequences.
 - 6. Parts list for manufactured equipment.
 - 7. Valve schedules.
 - 8. Lubrication instructions, including list/frequency of lubrication done during construction.
 - 9. Warranties.
 - 10. Additional information as indicated in the technical specification sections.
- C Provide a PDF file copy of all Operation and Maintenance (O&M) Manuals.

1.12 OWNER TRAINING

- A Instruct personnel in the proper operation and maintenance of systems and equipment provided as part of this project; video tape all training sessions. Include not less than 16 hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.

1.13 RECORD DRAWINGS

- A Refer to Division 1, General Requirements.
- B In addition to the data indicated in the General Requirements, maintain temperature control record drawings on originals prepared by the installing Contractor/Subcontractor. Include copies of these record drawings with the Operating and Maintenance manuals.

PART 2 PRODUCTS

2.01 ACCESS PANELS AND DOORS

- A Lay-in Ceilings:
 - 1. Removable lay-in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Division 09 are sufficient; no additional access provisions are required unless specifically indicated.
- B Concealed Spline Ceilings:
 - 1. Removable sections of ceiling tile held in position with metal slats or tabs compatible with the ceiling system used will be provided under Division 09.

C Plaster Walls and Ceilings:

1. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers, and similar wet areas, concealed hinges, screwdriver operated cam latch for general applications, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needing service; minimum size is 12" by 12".

2.02 IDENTIFICATION

A Stencils:

1. Not less than 1 inch high letters/numbers for marking pipe and equipment.

B Snap-On Pipe Markers:

1. Cylindrical self-coiling plastic sheet that snaps over piping insulation and is held tightly in place without the use of adhesive, tape or straps. Not less than 1 inch high letters/numbers and flow direction arrows for piping marking. W. H. Brady, Seton, Marking Services, or equal.

C Engraved Name Plates:

- a. White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 by Seton Name Plate Company or Emedolite- Style EIP by EMED Co., or equal by Marking Services, Brimar Industries, Inc. or W. H. Brady.

D Valve Tags:

1. Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains or brass "S" hooks around the valve stem, available from EMED Co., Seton Name Plate Company, Marking Services, Brimar Industries, Inc. or W. H. Brady.

2.03 SEALING AND FIRESTOPPING

A Refer to Section 07 84 00 - Firestopping.

B Fire and/or Smoke Rated Penetrations:

1. Manufacturers:

- a. 3M: www.3m.com.
- b. Hilti: www.hilti.com.
- c. Rectorseal: www.rectorseal.com.
- d. STI/SpecSeal: www.stifirestop.com.
- e. Tremco: www.tremcosealants.com.
- f. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2. All firestopping systems shall be provided by the same manufacturer.

C Submittals:

1. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
2. Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgment can be based upon.

D Product:

1. Fire stop systems shall be UL listed or tested by an independent testing laboratory.

2. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.
 3. Contractor shall use firestop putty, caulk sealant, intumescent wrap strips, intumescent firestop collars, firestop blocks, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail. Do not use intumescent materials at fire damper, or smoke damper penetrations.
- E Non-Rated Penetrations:
1. Pipe Penetrations Through Below Grade Walls:
 - a. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the cored opening or a water-stop type wall sleeve.
 2. Pipe Penetrations:
 - a. At pipe penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material.
 3. Duct Penetrations:
 - a. Annular space between duct (with or without insulation) and the non-rated partition or floor opening shall not be larger than 2 inch. Where existing openings have an annular space larger than 2 inch, the space shall be patched to match existing construction to within 2 inch around the duct.
 - b. Where shown or specified, pack annular space with fiberglass batt insulation or mineral wool insulation. Provide 4 inch sheet metal escutcheon around duct on both sides of partition or floor to cover annular space.

PART 3 EXECUTION

3.01 DEMOLITION

- A Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe or duct is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the Owner to minimize disruption to the existing building occupants.
- B All pipe, wiring and associated conduit, insulation, ductwork, and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor. All piping and ductwork specialties are to be removed from the site by the Contractor unless they are dismantled and removed or stored by the Owner. All designated equipment is to be turned over to the Owner for their use at a place and time so designated. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.

3.02 CONCRETE WORK

- A All cast in place concrete will be performed by the Division 3 Contractor unless otherwise noted. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support of mechanical equipment.

3.03 CUTTING AND PATCHING

- A Refer to Division 1, General Requirements.

3.04 BUILDING ACCESS

- A Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.05 EQUIPMENT ACCESS

- A Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance and service. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Access doors in general construction are to be furnished by the Mechanical Contractor and installed by the General Contractor.
- B Provide color coded thumb tacks or screws, depending on the surface, for use in accessible ceilings which do not require access panels.

3.06 COORDINATION

- A Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, diffusers, register, grilles, and recessed or semi recessed heating and/or cooling terminal units installed in/on architectural surfaces.
- B Coordinate all work with other Contractors prior to installation. Any installed work that is not coordinated and that interferes with other Contractor's work shall be removed or relocated at the installing Contractor's expense.
- C Cooperate with the test and balance agency in ensuring Section 23 05 93 specification compliance. Verify system completion to the test and balance agency (flushing, pressure testing, chemical treatment, filling of liquid systems, proper pressurization and air venting of hydronic systems, clean filters, clean strainers, duct and pipe systems cleaned, controls adjusted and calibrated, controls cycled through their sequences, etc.), ready for testing, adjusting and balancing work. Install dampers, shutoff and balancing valves, flow measuring devices, gauges, temperature controls, etc., required for functional and balanced systems. Demonstrate the starting, interlocking and control features of each system so the test and balance agency can perform its work.

3.07 IDENTIFICATION

- A Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion. Do not label equipment such as cabinet heaters and ceiling fans in occupied spaces.
- B Where stenciling is not appropriate for equipment identification, engraved name plates may be used.
- C Identify piping not less than once every 30 feet, not less than once in each room, adjacent to each access door or panel, and on both side of the partition where exposed piping passes through walls, floors or roofs. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a light background or white enamel against a dark background for stenciling or provide snap-on pipe markers as specified in Part 2 - Products.
- D Identify valves with brass tags bearing a system identification and a valve sequence number. Valve tags are not required at a terminal device unless the valves are greater than ten feet from the device or located in another room not visible from the terminal unit. Provide a typewritten valve schedule indicating the valve number and the equipment or areas supplied by each valve; locate schedules in each mechanical room and in each Operating and Maintenance manual. Schedules in mechanical rooms to be framed under clear plastic.
- E Use engraved name plates to identify control equipment.

3.08 SLEEVES

A Pipe Sleeves:

1. Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Patch wall around sleeve to match adjacent wall construction and finish. Grout area around sleeve in masonry construction. In finished spaces where pipe penetration through wall is exposed to view, sheet metal sleeve shall be installed flush with face of wall.
2. Pipe sleeves are not required in interior non-rated drywall, plaster or wood partitions and sleeves are not required in existing poured concrete walls where penetrations are core drilled.
3. Pipe sleeves in new poured concrete construction shall be schedule 40 steel pipe (sized to allow insulated pipe to run through sleeve), cast in place.
4. Extend the top of sleeve 1 inch above the adjacent floor in piping floor penetrations located in the mechanical rooms and wet locations listed below. In finished areas sleeves shall be flush with rough floor.
5. For floor pipe penetrations through existing floors in mechanical rooms, core drill opening and provide 1-1/2" x 1-1/2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8" on center. Seal corners water tight with urethane caulk. Or core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting, non-shrink grout. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to existing floor structure.
6. Pipe sleeves are not required in cored floor pipe penetrations through existing floors that are not located in mechanical rooms, food service areas or wet locations listed above.

B Duct Sleeves:

1. Duct sleeves are not required in non-rated partitions or floors.
2. Provide sleeve required for fire dampers in fire-rated partitions and floors. Reference fire damper details on drawings.
3. For duct penetrations through mechanical room floors, provide 1-1/2" x 1-1/2" x 1/8" galvanized steel angles fastened to floor around the perimeter of the duct opening to prevent water from getting to floor opening. Provide urethane caulk between angles and floor and fasten angles to floor 8" on center. Seal corners water tight with urethane caulk.

3.09 SEALING AND FIRESTOPPING

A Fire and/or Smoke Rated Penetrations:

1. Install approved product in accordance with the manufacturer's instructions where pipes penetrate a fire/smoke rated surface. When pipe is insulated, use a product which maintains the integrity of the insulation and vapor barrier. Provide a UL label at each penetration.
2. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support any substantial weight.

B Non-Rated Partitions:

1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with manufacturer's instructions.

2. At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.
3. Duct penetrations through non-rated partitions shall require sheet metal escutcheons with fiberglass or mineral wool insulation fill for spaces that include laboratories, clean rooms, animal rooms, kitchens, cart wash rooms, janitor closets, cart wash rooms, toilet rooms, mechanical rooms, conference rooms, private consultation rooms, and where noted on drawings elsewhere.

3.10 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under Division 1.

END OF SECTION 23 05 00

SECTION 23 05 02 MECHANICAL DEMOLITION AND ALTERATIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A Drawings and general provisions of Contract, including General and Supplementary Conditions, Special Conditions, and Division-1 Specification sections, apply to work specified in this section.

1.02 JOB CONDITIONS

- A Perform all demolition as needed to accomplish new work.
- B Refer to Demolition Section of specifications and to the Drawings for areas and equipment being remodeled.
- C This Contractor is responsible for all charges, fees etc. incurred as a result of the mechanical portion of the demolition.
- D Prior to demolition or alteration of structures, the following shall be accomplished:
 - 1. Coordinate sequencing with Owner and other Contractors.
 - 2. Coordinate means to separate construction zones from non-renovated zones to prevent the spread of dust, fumes and debris.
 - 3. Coordinate means to provide exhaust and makeup air to maintain the construction zone at an adequate negative pressure to contain all construction dust and fumes.
 - 4. Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work.
 - 5. Equipment noted to be removed and turned over to the Owner, shall be delivered to the Owner at a place and time he so designates.
 - 6. Where the materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.
 - 7. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restore existing facilities to their pre-demolition condition, at no additional cost to Owner.
 - 8. Salvage equipment scheduled for reuse in new work or scheduled to be delivered to Owner's storage facility.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 DEMOLITION

- A Existing mechanical equipment in conflict with new construction shall be removed and/or relocated as indicated on the drawings, as directed or needed. This Contractor shall remove all mechanical equipment released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. Except for ductwork and miscellaneous hardware, all mechanical equipment shall remain the property of the Owner and shall be stored on the site for removal by the Owner. Properly dispose or remove from site any piping, hangers, or other items not retained by Owner.

- B Where materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.
- C Any existing services or equipment not shown on the drawings, and which are logically expected to be continued in service and which may be interrupted or disturbed during construction, shall be reconnected in an approved manner. Provide temporary ducts, pipes, controls, etc., as needed to prevent interruption of service to occupied areas caused by demolition operations. In addition, any ductwork, piping or equipment which may require relocation or rerouting as a result of construction, shall be considered a part of the work of this section and shall be done by this Contractor with no additional compensation, provided that the referenced relocation is discernable from the pre-bid review of the site, and associated documents.
- D This Contractor shall remove all ductwork, piping, straps, and existing equipment, being discontinued or removed due to construction. Abandoned or removed services shall be disconnected and capped at the perimeter of the project or as required elsewhere in the documents.
- E The existing building is to remain in operation during construction. This Contractor shall coordinate all work that will interfere with the present operation of the facility with the Owner and Construction Manager.
- F All existing equipment that is to remain shall be cleaned. Touch up paint equipment in exposed areas.
- G Ductwork systems indicated to remain shall be cleaned inside and out.
- H Existing ductwork in remodeled area that is not being removed shall be sealed as necessary to comply with SMACNA standards and requirements of ductwork section of the specifications.
- I All coring that is required for mechanical work shall be done by this Contractor.
- J All cutting and patching required for mechanical work shall be by this Contractor.
- K This Contractor shall provide required additional support for existing ductwork and piping in remodeled area that is not being removed and is not properly supported in accordance with Specification Sections 23 05 15 and 23 37 13.
- L When existing ductwork, piping, or related equipment in remodeled areas prevents the installation of other work, remove and reinstall existing materials, making necessary modifications and transitions to coordinate with other trades.
- M Maintain construction zone at adequate negative pressure by providing exhaust by mechanical means until all work which creates dust or fumes is completed.

3.02 TESTING

- A Existing equipment shall be tested before demolition begins to determine existing operating conditions and capacities. Upon completion of all new work, the existing equipment shall be rebalanced to serve the new areas and maintain existing capacities in existing areas.

END OF SECTION 23 05 02

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

- A This section includes requirements for single and three phase motors that are used with equipment specified in other sections. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operating and Maintenance Data.
 - h. Electrical Coordination.
 - i. Product Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Three Phase, Single Speed Motors.
 - b. Single Phase, Single Speed Motors.
 - c. Motors Used with Variable Frequency Drives.
 - d. Electronically Commutated Motors (ECM).
 - 3. PART 3 – EXECUTION.
 - a. Installation.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
- B Section 23 05 14 - Variable Frequency Drives.
- C Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- D Division 26 00 00 - Electrical.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ANSI/IEEE 112 Test Procedure for Polyphase Induction Motors and Generators.
- B ANSI/NEMA MG-1 Motors and Generators.
- C ANSI/NFPA 70 National Electrical Code.

1.05 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.06 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Include with the equipment which the motor drives the following motor information: motor manufacturer, horsepower, voltage, phase, hertz, rpm, full load efficiency. Include project wiring diagrams prepared by the Contractor specifically for this work.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.08 ELECTRICAL COORDINATION

- A All starters, overload relay heater coils, disconnect switches and fuses, relays, wire, conduit, pushbuttons, pilot lights, and other devices required for the control of motors or electrical equipment are furnished and installed by the Electrical Contractor, except as specifically noted elsewhere in this division of specifications.
- B Electrical drawings and/or specifications show number and horsepower rating of all motors furnished by this Contractor, together with their actuating devices if these devices are furnished by the Electrical Contractor. Should any discrepancy in size, horsepower rating, electrical characteristics or means of control be found for any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify the Engineer of such discrepancy. Costs involved in any changes required due to equipment substitutions initiated by this Contractor will be the responsibility of this Contractor. See related comments in Section 23 05 00 - Common Work Results for HVAC, under Shop Drawings.
- C Electrical Contractor will provide all power wiring and control wiring, except temperature control wiring.
- D Furnish project specific wiring diagrams to Electrical Contractor for all equipment and devices furnished by this Contractor and indicated to be wired by the Electrical Contractor.

1.09 PRODUCT CRITERIA

- A Motors to conform to all applicable requirements of NEMA, IEEE, ANSI, and NEC standards and shall be listed by U.L. for the service specified.
- B Select motors for conditions in which they will be required to perform, i.e., general purpose, splash proof, explosion proof, standard duty, high torque or any other special type as required by the equipment or motor manufacturer's recommendations.
- C Furnish motors for starting in accordance with utility requirements and compatible with starters as specified.

PART 2 PRODUCTS

2.01 THREE PHASE, SINGLE SPEED MOTORS

- A Use NEMA rated 208 volt, three phase, 60 hertz motors for all motors 1/2 HP and larger unless specifically indicated.
- B Use NEMA general purpose, continuous duty, Design B, normal starting torque, T-frame or U-frame motors with Class B or better insulation unless the manufacturer of the equipment on which the motor is being used has different requirements. Use open drip-proof motors unless totally enclosed fan-cooled, totally enclosed non-ventilated, explosion-proof, or encapsulated motors are specified in the equipment sections.
- C Use grease lubricated anti-friction ball bearings with housings equipped with plugged/capped provision for re-lubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at the end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- D All open drip-proof motors to have a 1.15 service factor. Other motor types may have minimum 1.0 service factors.
- E All motors 1 HP and larger, except specially wound motors and inline pump motors 56 frame and smaller, to be high efficiency design with full load efficiencies which meet or exceed the values listed below when tested in accordance with NEMA MG 1.

FULL LOAD NOMINAL MOTOR EFFICIENCY BY MOTOR SIZE AND SPEED

MOTOR HP	----Open Drip-Proof Motors-----		
	-----Nominal Motor Speed-----		
	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	77.0
1-1/2	86.5	86.5	84.0
2	87.5	86.5	85.5
3	88.5	89.5	85.5
5	89.5	89.5	86.5
7-1/2	90.2	91.0	88.5
10	91.7	91.7	89.5
15	91.7	93.0	90.2
20	92.4	93.0	91.0

MOTOR HP	----Totally Enclosed Fan-Cooled----		
	-----Nominal Motor Speed-----		
	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	77.0
1-1/2	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5
7-1/2	91.0	91.7	89.5
10	91.0	91.7	90.2
15	91.7	92.4	91.0
20	91.7	93.0	91.0

2.02 SINGLE PHASE, SINGLE SPEED MOTORS

- A Use NEMA rated 115 volt, single phase, 60 hertz motors for all motors 1/3 HP and smaller.
- B Use permanent split capacitor or capacitor start, induction run motors equipped with permanently lubricated and sealed ball or sleeve bearings and Class A insulation. Service factor to be not less than 1.35.

2.03 MOTORS USED WITH VARIABLE FREQUENCY DRIVES

- A In addition to the requirements specified above, the motor must be suitable for use with the drive specified in Section 23 05 14, including but not limited to motor cooling. Motor shall comply with NEMA MG1 Part 31 to provide windings capable to withstand up to 1600 peak Volts with a rise time of 0.1 μs. Provide bearing protection grounding rings to bleed current from the motor shaft to the motor casing.
- B Manufacturers:
 1. Aegis SGR: www.est-aegis.com.
 2. Inpro/Seal CDR: www.inpro-seal.com.

3. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.04 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A Motor to be a brushless DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy duty ball bearings to match the fan load and pre-wired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal. Motor shall be a minimum of 85% efficient at all speeds.
- B Provide as Scheduled.

PART 3 EXECUTION

3.01 INSTALLATION

- A Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot to get a secure installation.
- B When motor will be flexible coupled to the driven device, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Using a dial indicator, check angular misalignment of the two shafts; adjust motor position as necessary so that the angular misalignment of the shafts does not exceed 0.002 inches per inch diameter of the coupling hub. Again using the dial indicator, check the shaft for run-out to assure concentricity of the shafts; adjust as necessary so that run-out does not exceed 0.002 inch.
- C When motor will be connected to the driven device by means of a belt drive, mount sheaves on the appropriate shafts in accordance with the manufacturer's instructions. Use a straight edge to check alignment of the sheaves; reposition sheaves as necessary so that the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so that the belt(s) can be added and tighten the base so that the belt tension is in accordance with the drive manufacturer's recommendations. Frequently recheck belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.
- D Verify the proper rotation of each three-phase motor as it is being wired or before the motor is energized for any reason.
- E Lubricate all motors requiring lubrication. Record lubrication material used and the frequency of use. Include this information in the maintenance manuals.

END OF SECTION 23 05 13

SECTION 23 05 14 VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SCOPE

- A This section includes variable frequency drives, bypass starters, and line reactors. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Submittals.
 - f. Operating and Maintenance Data.
 - g. Equipment Startup.
 - h. Warranty.
 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Design and Construction.
 - c. Performance Requirements.
 - d. Control Features.
 - e. Protection Features.
 - f. Diagnostics.
 - g. Quality Assurance Tests.
 - h. Bypass Equipment.
 - i. AC Input Line Reactors.
 - j. Output Line Filters.
 3. PART 3 – EXECUTION.
 - a. Variable Frequency Drives (VFD).
 - b. Construction Verification Items.
 - c. Functional Performance Testing.
 - d. Owner Training.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 21 23 - Hydronic Pumps.
C Section 23 34 00 - HVAC Fans.
D Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units.
E Section 26 05 26 - Grounding and Bonding for Electrical Systems.
F Section 26 05 29 - Hangers and Supports for Electrical Systems.
G Section 26 05 53 - Identification for Electrical Systems.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ANSI/IEEE 519 Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

1.05 SUBMITTALS

- A Submit shop drawings and product data under provisions of Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Include physical, electrical, and performance characteristics of each variable frequency drive and associated components, including dimensions; weight; input and output performance; voltage, phase, current and overcurrent characteristics; installation instructions; protective features; wiring and block diagrams indicating specified options; electrical noise attenuation equipment where required to meet the criteria specified; line side voltage notch wave form and line side current harmonics; certified efficiency versus load and speed curves; and required operating environment.

1.06 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.07 EQUIPMENT STARTUP AND OWNER TRAINING

- A Provide the services of a factory trained and certified technician to approve the installation; start-up, test, and adjust for proper operation of the unit(s). Upon completion of the equipment startup, submit a complete manufacturer's field report, including startup and test log, signed by the factory trained technician. Coordinate with the Temperature Control Contractor and the Balancing Contractor. The startup shall be coordinated with Division 26 Electrical and shall be completed within ten (10) working days from the startup date as set by the Owner's representative.

1.08 WARRANTY

- A The warranty shall be for a period of twenty-four (24) months from the date of project Substantial Completion. Further, the warranty shall include all parts, labor, travel time, administrative costs, overhead, travel expenses, technical support and any and all other costs to provide the warranty service.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A ABB: www.abb.com.
- B Toshiba: www.toshiba.com.
- C Danfoss: www.danfoss.com.
- D GE Fuji: www.geindustrial.com.
- E Safronics: www.saftronics.com.
- F Yaskawa: www.yaskawa.com.
- G Eaton/Cutler Hammer: www.eaton.com.
- H Mitsubishi: www.meau.com.
- I Allen Bradley: www.ab.com.
- J Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.02 DESIGN AND CONSTRUCTION

- A The unit shall be variable torque, modular design for control of the motors as specified in Division 23 and rated at the motor full load nameplate amps.
- B The unit shall be U.L. listed, solid state, microprocessor-based with a pulse width modulated (PWM) output wave form (none others are acceptable).

- C The VFD shall employ a full wave bridge rectifier and capacitors to minimize the ripple of the rectified voltage to maintain near constant DC voltage. Insulated gate bipolar transistors (IGBT's) shall be employed as the output switching device.
- D The VFD package shall contain the equivalent of 5% impedance to reduce harmonic distortion. The 5% equivalent impedance shall be provided in the form of a DC bus choke, an input AC line reactor in each phase, or a combination of the two methods.
- E Control circuitry shall be plug-in, plug-out modular basis with a corrosion resistant coating on printed circuit boards.
- F Units to be suitable for an operating environment from 0°C to 40°C temperature and humidity up to 90% non-condensing.
- G Electrically and physically isolate control circuitry and conductors from power circuitry and power conductors. Control conductors and power conductors shall not be run in the same pathway.
- H The unit enclosure shall be NEMA 1 as required for the application minimum and all components shall be fully factory assembled and tested prior to leaving the manufacturing facility.
- I Include the following operating and monitoring devices mounted on the front cover:
 - 1. A disconnect switch or circuit breaker to de-energize both the drive and bypass circuit with door interlocked handle and lock-open padlocking provisions.
 - 2. Operating mode selector switch marked "hand-off-auto".
 - 3. Manual speed adjustment via keypad, mounted on the door.
 - 4. Manual bypass selector switch to select power through drive or bypass (if a bypass is provided).
- J Provide a manual bypass circuit and bypass starter to transfer from variable frequency drive operation to bypass operation (if a bypass is provided).

2.03 PERFORMANCE REQUIREMENTS

- A Units shall be suitable for input power of electrical system as scheduled on the drawings $\pm 10\%$, 3 phase, 60 Hertz nominal.
- B Use a current limiting control device to limit output current to 110% continuous for one minute; also refer to Protection Features in this section. Full load output current available from drive shall not be less than motor nameplate amperage. The full load amp rating of the VFD shall not be less than the values indicated in the NEC Table 430-250.
- C Output power shall be suitable for driving standard NEMA B design, three phase alternating current induction motors at full rated speed with capability of 6:1 turndown.
- D Additional performance capabilities to include the following:
 - 1. Ride through a momentary power outage of 15 cycles.
 - 2. Start into a rotating load without damage to drive components or motor.
 - 3. Capable of automatic restart into a rotating load after a preset, adjustable time delay following a power outage.
 - 4. Input power factor: Min 0.95 throughout the speed range.
 - 5. Minimum efficiency: 95% at 100% speed, 85% at 50% speed.
 - 6. Adjustable thermal overload protection: Class 10.20.30.

2.04 CONTROL FEATURES

- A Use control circuits compatible with input signal from temperature control system in the automatic mode and from manual speed control in the manual mode. Vary motor speed in response to the input control signal. Include components necessary to accept the signal from the temperature control system in the form that it is sent. Refer to Division 23.

- B Include the following additional control features:
1. Hand-Off-Automatic (HOA) selector switch to select local or remote start/stop and speed control.
 2. Analog input, selectable 0-10v or 4-20 mA, for automatic control from the temperature control system.
 3. Local speed control at the VFD.
 4. Adjustable acceleration and deceleration rate so that the time period from start to full speed and from full speed to stop can be field adjusted.
 5. Adjustable minimum and maximum speed settings for both automatic and manual modes of operation.
 - ~~6.~~ Manual transfer bypasses circuit.
 7. Field adjustment of minimum and maximum output frequency.
 8. Two (2) sets of programmable form "C" contacts for remote indication of variable frequency drive condition. Note: default programming to be set for "Drive Run & Fault".
 9. Illuminated display keypad.
 10. External Fault indicator.
 11. One (1) input for a N.O. dry contact type input for a 2-wire remote start/stop.
 12. One (1) input for a N.C. dry contact type input for external faults: (freezestats, fire alarm, smokes, etc). This input shall be factory wired to prevent both the VFD and bypass starter operation when external fault is present.
 13. One (1) N.O. dry contact output for proving motor status. This output shall be programmed to detect belt or coupling break that would remove the load from the motor. The dry contact will open on loss of load or VFD being off.
 14. PID control loop capable of VFD control from an external device connected to a VFD analog input.
- C The VFD controller shall convert VFD information into the BACnet MSTP protocol that will be compatible with the building direct digital energy management system (EMS) supplied on the project. This output shall be through a serial interface port capable of two-way communication with the building EMS provided on this project. Final connection shall not require any additional intermediate gateway devices to provide throughput of data. The following data shall be provided at a minimum:
1. Fault condition.
 2. Speed.
 3. Amperage.
 4. Frequency.
 5. Voltage.
 6. Bypass status (if supplied).

2.05 PROTECTION FEATURES

- A Use electronic protection circuitry in the power circuits to provide an orderly shutdown of the drive without blowing fuses or tripping circuit breakers and prevent component loss under the following abnormal conditions:
1. Activation of any safety device.
 2. Instantaneous overcurrent and/or over voltage of output.
 3. Power line overvoltage and undervoltage protection.
 4. Phase loss.
 5. Single and three phase short circuiting.

6. Ground faults.
 7. Control circuit malfunction.
 8. Overtemperature.
 9. Output current over limit.
- B Provide the following additional protective features:
1. Input transient overvoltage protection up to 3000 volts per ANSI 37.90A.
 2. DC bus fusing or other electronic controls which limit the rate of rise of the DC bus current and de-energizes the drive at a predetermined current level.
 3. Fusing for the control circuit transformer.
 4. Grounded control chassis.
 5. Devices and/or control circuitry to ensure that the variable frequency drive and bypass starter are not both energized and driving motor simultaneously.

2.06 DIAGNOSTICS

- A Provide an English character display (no error codes) with indicators for the following:
1. Phase loss.
 2. Ground fault.
 3. Overcurrent.
 4. Overvoltage.
 5. Undervoltage.
 6. Over temperature.
 7. Overload.
 8. DC bus status.

2.07 QUALITY ASSURANCE TESTS

- A Use a factory heat stress test to verify proper operation of all functions and components under full load.
- B Field performance test of variable frequency drives to determine compliance with this specification will be performed at the Owner's discretion and may include any specified feature, including operation of protective devices through a simulated fault. Contractor will pay for initial testing. Should drive be found deficient by this testing, drive manufacturer will be required to make any and all changes necessary to bring unit(s) into compliance with the specified performance and demonstrate this performance by retesting. Cost of changes and retest will be by this Contractor.
- C Variable frequency drive manufacturer or designated representative to perform a field test of each drive, in the presence of the Owner's representative, for the following items:
1. Provide general inspection to verify proper installation.
 2. Demonstrate drive reaction to simulated power interruptions of two seconds and sixty seconds.
 3. Demonstrate adequate protection during switching from variable frequency drive operation to bypass starter operation and back again.

2.08 BYPASS EQUIPMENT

- A Bypass Starters:
1. The bypass starters for 208 volt motors, 20 HP and less; and 480 volt motors, 40 HP and less, shall be across-the-line magnetic starter type.
 2. The bypass starters for 208 volt motors, 25 HP and more; and 480 volt motors, 50 HP and more, shall be solid state reduced voltage starting type.

- B Bypass Configuration:
 - 1. Provide one main disconnect switch or circuit breaker to de-energize both the drive and bypass circuit. Provide a drive input disconnect switch or fuse block to allow the drive to be isolated while the bypass circuit is energized. Provide one output drive contactor and one output bypass contactor. The two output contactors shall be electrically interlocked to allow only one contactor to be closed at any one time.
- C Provide motor overload protection in the bypass circuit.
- D Provide bypass equipment in a common enclosure with the VFD or, if not available, in a separate enclosure.

2.09 AC INPUT LINE REACTORS

- A When needed to comply with the requirement for 5% equivalent impedance, furnish and factory install AC input line reactors.
- B Line reactors shall be installed in each phase of the AC input side of the VFD and mounted within a common enclosure with the VFD.
- C Line reactor shall be a three phase inductor, iron core, 600V, Class H insulation, 115 degree C rise, copper windings with screw type terminal blocks.

2.10 OUTPUT LINE FILTER

- A Provide a three phase dV/dT output filter for any 460VAC drive with output line length of over 120 feet or as specified.

PART 3 EXECUTION

3.01 VARIABLE FREQUENCY DRIVES

- A Install where indicated on drawings and in accordance with approved submittals and manufacturer's published recommendations. Installation to be by the Division 26 Electrical Contractor.
- B Input power wiring shall be installed in a separate conduit, output power wiring shall be installed in a separate conduit and control wiring shall be installed in a separate conduit. Do not mix input power, output power, or control wiring in a common conduit. Separate conduits for input and output power wiring shall be provided for each motor. Input and output power wiring for more than one motor shall not share a common conduit. Power wiring shall be furnished and installed by the Div. 26 Contractor. If provided, do not mount output line filter above the drive.
- C Control signal for drive will be provided under Division 23.
- D Temperature Control Contractor will furnish and install the required temperature control wiring in metal conduit and in accordance with Division 26 Electrical of this specification.

3.02 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

3.03 FUNCTIONAL PERFORMANCE TESTING

- A Contractor is responsible for utilizing the functional performance test procedures supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for functional performance test procedures.

3.04 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 - Commissioning Process.

- B Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of **4** hours.

END OF SECTION 23 05 14

INTENTIONALLY LEFT BLANK

SECTION 23 05 15 PIPING SPECIALTIES

PART 1 GENERAL

1.01 SCOPE

A This section contains specifications for HVAC piping specialties for all piping systems. Included are the following topics:

1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Quality Assurance.
 - e. Shop Drawings.
 - f. Operation and Maintenance Data.
 - g. Design Criteria.
2. PART 2 – PRODUCTS.
 - a. Thermometers.
 - b. Thermometer Sockets.
 - c. Test Wells.
 - d. P/T (Pressure/Temperature) Test Plugs.
 - e. Hose Connection Caps.
 - f. Pressure Gauges.
 - g. Expansion Loops.
 - h. Expansion Compensators.
 - i. Expansion Joints (Bellows type).
 - j. Strainers.
 - k. Air Vents.
 - l. Flow Sensing Devices.
 - m. Differential Pressure Gauge.
3. PART 3 – EXECUTION.
 - a. Thermometers.
 - b. Thermometer Sockets.
 - c. Test Wells.
 - d. P/T (Pressure/Temperature) Test Plugs.
 - e. Pressure Gauges.
 - f. Expansion Loops.
 - g. Expansion Compensators.
 - h. Expansion Joints (Bellows type).
 - i. Strainers.
 - j. Air Vents.
 - k. Flow Sensing Devices.
 - l. Differential Pressure Gauge.
 - m. Hose Kits.

n. Construction Verification Items.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
- B Section 23 05 23 - General-Duty Valves for HVAC Piping.
- C Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- D Section 23 07 00 - HVAC Insulation.
- E Section 23 21 13 - Hydronic Piping.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.05 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Required for all items in this section. Include materials of construction, dimensional data, ratings/capacities/ranges, pressure drop data where appropriate, and identification as referenced in this section and/or on the drawings.

1.06 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.07 DESIGN CRITERIA

- A All piping specialties are to be rated for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

PART 2 PRODUCTS

2.01 THERMOMETERS

- A Manufacturers:
 - 1. Ashcroft: www.ashcroft.com.
 - 2. Marsh.
 - 3. Taylor: www.taylorusa.com.
 - 4. H. O. Trerice: www.trerice.com.
 - 5. Ametek/U. S. Gauge Division: www.ametekusg.com.
 - 6. Weiss: www.weissinstruments.com.
 - 7. Weksler: www.weksler-gauges.com.
 - 8. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Stem Type, cast aluminum case, nine inch scale, clear acrylic window. adjustable angle brass stem with stem of sufficient length so the end of the stem is near the middle of a pipe without reducing the thickness of any insulation, red indicating fluid, black lettering against a white background, with scale ranges as follows:

Service	Scale Range, °F	Min. Increment, °F
Hot Water	30 - 240	2

2.02 THERMOMETER SOCKETS

- A Brass with threaded connections suitable for thermometer stems and temperature control sensing elements in pipeline. Furnish with extension necks for insulated piping systems.

2.03 TEST WELLS

- A Similar to thermometer sockets except with a brass cap that thread into the inside of the test well to prevent dirt from accumulating. Secure cap to body with a short chain. Furnish with extension necks, where appropriate, to accommodate the pipeline insulation.

2.04 P/T (PRESSURE/TEMPERATURE) TEST PLUGS

- A Brass plug with 1/4" NPT threads, EPDM or neoprene valve core, knurled cap with cap strap. Use extended length plugs to clear insulated piping. Adaptors shall have 1/4" FPT connection for standard pressure gauges.

2.05 HOSE CONNECTION CAPS

- A Hose connection caps shall be pressure rated for 150 psig at 180 deg F.

2.06 PRESSURE GAUGES

- A Manufacturers:

1. Ametek/U. S. Gauge Division: www.ametekusg.com.
2. Ashcroft: www.ashcroft.com.
3. Marsh.
4. Taylor: www.taylorusa.com.
5. H. O. Trerice: www.trerice.com.
6. Weiss: www.weissinstruments.com.
7. Weksler: www.weksler-gauges.com.
8. Substitutions: Refer to Section 01 60 00 - Product Requirements.

- B Cast aluminum case of not less than 4.5 inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from the front of the dial, 99% accuracy over the middle half of the scale, 98.5% accuracy over the remainder of the scale, with scale range as follows:

Service	Scale Range, psig	Min. Increment, psig
Hot Water		

- C Pressure Snubbers:

1. Bronze construction, suitable for system working pressure, 1/4 inch size.

- D Coil Syphons:

1. Bronze or steel construction, suitable for system working pressure, 1/4 inch size.

- E Gauge Valves:

1. Use valves as specified in Section 23 05 23 - General-Duty Valves for HVAC Piping. For water systems, use 1/4 inch ball valves. For steam systems, use 1/4 inch gate valves suitable for system working pressure.

2.07 EXPANSION LOOPS

- A Provide expansion loops indicated on the drawings and details.

2.08 EXPANSION COMPENSATORS

- A Manufacturers:

1. MetraFlex; HP series, Vibrations Mountings and Controls: www.metroflex.com.
2. Hyspan: www.hyspan.com.
3. Flexonics; Model H or HP: www.flexonics.ca.
4. Substitutions: Refer to Section 01 60 00 - Product Requirements.

- B Constructed of two ply stainless steel bellows with carbon steel shrouds, carbon steel threaded or flanged end fittings or copper solder joint fittings, internal guides for the full length of the bellows travel, and positive internal anti-torque device to prevent twist or torque during installation. Units to be rated at 150 psi at not less than 400°F.

2.09 EXPANSION JOINTS (BELLOWS TYPE)

- A Manufacturers:
 - 1. Adscor Corruflex: www.adscomfg.com.
 - 2. Flexonics High Corr: www.flexonics.ca.
 - 3. Hyspan: www.hyspan.com.
 - 4. MetraFlex: www.metraflex.com.
 - 5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Flanged, packless, self-equalizing type constructed of type 304 stainless steel bellows and carbon steel fittings. Construct control rings of cast steel or nickel iron. Include limit stops and tie rods to prevent over traversing and to constrain pressure thrust forces on the joints. Units to be rated at 150 psi at not less than 400°F.
- C Include an external sheet metal shroud on all joints that will be insulated. Shroud to be removable for field inspection of the joint.
- D Include an internal sleeve of 304 stainless steel with sufficient clearance between the bellows and the sleeve to permit full rated rotational and lateral movement. Inside diameter of sleeve is not to be less than that of the adjoining pipe.

2.10 STRAINERS

- A Manufacturers:
 - 1. Armstrong: www.armstronginternational.com.
 - 2. Hoffman: www.hoffmanspecialty.com.
 - 3. Keckley: www.keckley.com.
 - 4. Metraflex: www.metraflex.com.
- B WATER SYSTEMS:
 - 1. Y type; cast iron body; stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; threaded body in sizes through 2 inch and rated at not less than 175 psi WOG; flanged body in sizes over 2 inch and rated at not less than 125 psi WOG at 240°F. Screen to be 20 mesh for line sizes 2 inch and less, 0.125 inch perforations for line sizes 2-1/2 inch through 4 inch, and 0.25 inch perforations for line sizes 5 inch and larger.
- C BASKET TYPE: Cast iron body with clamped cover; stainless steel screens; body tapped for a blowoff valve; 125 psig flanged body for 2-1/2 inch and larger; 0.125 inch perforations for line sizes 2-1/2 inch through 4 inch, and 0.25 inch perforations for line sizes 5 inch and larger.
- D WATER SYSTEMS WITH DESIGN PRESSURES OVER 150 PSIG:
 - 1. Y type: cast iron or cast steel body; stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; threaded or socket weld body in sizes through 2 inch and rated at not less than 300 psi WOG at 150°F; flanged or butt weld body in sizes over 2 inch and rated at not less than 300 psi WOG at 150°F. Screen perforations to be 0.057 inch for line sizes 2 inch and less, 0.125 inch for line sizes 2-1/2 inch through 4 inch, and 0.25 inch for line sizes 5 inch and larger.

2.11 AIR VENTS

- A MANUAL KEY TYPE VENTS:
 - 1. Bell and Gossett Model 4V; Eaton/Dole Model 9, 9B, or 14A.

2. Bronze body with nonferrous internal parts, screwdriver operated, designed to relieve air from the system when vent is opened, rated at not less than 125 psig at 220°F.
- B MANUAL BALL VALVE VENTS:
1. Provide 1/4 inch ball valves for manual venting of air handling unit coils and where indicated elsewhere on drawings and details. Reference specifications Section 23 05 23.
- C AUTOMATIC VENTS:
1. Thrush Model 720, Bell and Gossett Model 107, Watson McDaniel Model AV813W
 2. Cast iron body with nonferrous internal parts, designed to vent air automatically with float principle without allowing air to enter the system, rated at not less than 125 psig at 220°F.

2.12 FLOW SENSING DEVICES

- A For water flow sensing devices 2 inch and smaller, use balance valves as specified in Section 23 05 23 - General-Duty Valves for HVAC Piping.
- B PITOT TUBE FLOW SENSORS - TYPE 1:
1. Manufacturers:
 - a. Dieterich Standard/Annubar.
 - b. Preso: www.preso.com.
 - c. Substitutions: Refer to Section 01 60 00 - Product Requirements.
 2. Multi-port averaging type flow sensor designed to sense the velocity of a fluid flowing in a pipe and produce a pressure output that is proportional to the fluid velocity. Sensor to consist of a type 316 stainless steel probe with a diamond or elliptical shape of sufficient length to sense flow completely across the pipe section and to accommodate the insulation specified for the pipeline; brass body gate, needle, or ball instrument connection valves with appropriate fitting for connection to a meter; single forged steel weld type installation fitting for pipe sizes through 6 inch, double forged steel weld type installation fittings for use on opposite ends of the sensor for larger pipe sizes if recommended by the manufacturer for the application; accurate within 2% of the actual flow with a turndown ratio of 10:1 or better; permanently stamped nameplate attached to the sensor indicating the flow/differential pressure characteristics of the sensor; suitable for use on systems to 150 psig at 250°F.

2.13 DIFFERENTIAL PRESSURE GAUGE

- A Manufacturers:
1. Barton 247A: www.bartoninstruments.net.
 2. Midwest 809: www.midwestinstrument.com.
 3. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Bellows type differential pressure meter kit that includes a six inch diameter gauge with a 270° arc having an accuracy of $\pm 1\%$ of full scale or better and suitable for the differential pressures of the flow meters supplied for this project, over range protection on the meter, color coded hoses not less than ten feet in length with brass connectors suitable for connection to the low and high pressure connections on the balance valves, inline strainers, instrument valving so meter can be vented and drained, pressure and temperature rating at least equal to that of the valves. Provide meter and all accessories in a durable case with carrying handle.

PART 3 EXECUTION

3.01 THERMOMETERS

A STEM TYPE:

1. Install in piping systems as indicated on the drawings and/or details using a separable socket in each location.

B DIAL TYPE FOR AIR TEMPERATURE MEASUREMENT:

1. Install in ductwork where detailed or specified. Support capillary inside duct so it measures a uniform sample of air. Mount readout so it is readily visible on a portion of ductwork that is not externally insulated or on a sheetmetal angle support secured to a nearby structural element.

3.02 THERMOMETER SOCKETS

- A** Install at each point where a thermometer or temperature control sensing element is located in a pipeline.

3.03 TEST WELLS

- A** Install in piping systems as indicated on the drawings and/or details wherever provisions are needed for inserting a thermometer at a later date.

3.04 P/T (PRESSURE/TEMPERATURE) TEST PLUGS

- A** Install in piping systems as indicated on the drawings and/or details. Do not insulate over test plugs.

3.05 PRESSURE GAUGES

- A** Install in locations where indicated on the drawings and/or details, including any gauge piping, with scale range appropriate to the system operating pressures.

B PRESSURE SNUBBERS:

1. Install in gauge piping for all gauges used on water services.

C COIL SYPHONS:

1. Install in gauge piping for all gauges used on steam services.

D GAUGE VALVES

1. Install at each gauge location as close to the main as possible and at each location where a gauge tapping is indicated.

3.06 EXPANSION LOOPS

- A** Install where indicated on the drawings or details, locating anchors and guides as detailed.

3.07 EXPANSION COMPENSATORS

- A** Install where indicated on the drawings or details, locating anchors and guides as detailed.

3.08 EXPANSION JOINTS (BELLOWS TYPE)

- A** Install where indicated on the drawings or details, locating anchors and guides as detailed. Do not stretch joint to accommodate pipe misalignment or end-to-end spacing. Remove all shipping rods and spacers and clean inside of joint before placing in service.

3.09 STRAINERS

- A** Install all strainers where indicated on the project details, allowing sufficient space for the screens to be removed. Rotate screen retainer where required by the installation so blowdown can remove accumulated dirt from the strainer body.

B WATER SYSTEMS:

1. Install a ball valve for blowdown in the tapped screen retainer; valve to be the same size as the tapping.

3.10 AIR VENTS

A MANUAL KEY TYPE VENTS:

1. Install at all high points where air may collect and not be carried by the system fluid. Use a soft Type L copper "pigtail" so the vent can be positioned for venting and collecting any water that might escape.

B MANUAL BALL VALVE VENTS:

1. Install on air handling coils and where indicated elsewhere as shown on drawings and details.

C AUTOMATIC VENTS:

1. Install on the top of air separators on systems using bladder type expansion tanks. Install at other locations as indicated on the drawings or details. All locations to have a ball valve installed upstream of the vent for maintenance purposes.

3.11 FLOW SENSING DEVICES

A PITOT TUBE FLOW SENSORS:

1. Install where indicated on the drawings and details for flow sensing in hydronic and/or steam piping systems. Butterfly valves installed at the location of a flow sensing device are to have a memory stop.

3.12 DIFFERENTIAL PRESSURE GAUGE

- #### **A**
- Handle as a loose and detachable part as outlined in the General Requirements.

3.13 HOSE KITS

- #### **A**
- Pre-manufacture hose kits may be used for connection to any fan-coil, blower-coil, or terminal unit as long as all components meet the specifications, and the hoses meet the pressure rating of the system. Hose connections may not be longer than 18 inch and may not be used for a change in direction.

3.14 CONSTRUCTION VERIFICATION ITEMS

- #### **A**
- Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

END OF SECTION 23 05 15

INTENTIONALLY LEFT BLANK

SECTION 23 05 23 GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SCOPE

- A This section includes valve specifications for all HVAC systems except where indicated under Related Work. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Quality Assurance.
 - e. Submittals.
 - f. Design Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Water System Valves.
 - 1) Ball Valves.
 - 2) Butterfly Valves.
 - 3) Globe Valves.
 - 4) Spring Loaded Check Valves.
 - 5) Balance Valves.
 - 6) Drain Valves.
 - 7) Combination Shut-off, Check, and Balancing Valves.
 - 3. PART 3 – EXECUTION.
 - a. General.
 - b. Shut-off Valves.
 - c. Balancing Valves.
 - d. Drain Valves.
 - e. Spring Loaded Check Valves.
 - f. Combination Shut-off, Check, and Balancing Valves.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
- B Section 23 05 15 - Piping Specialties.
- C Section 23 09 13 - Instrumentation and Control Devices for HVAC.

1.03 REFERENCE

- A Applicable provisions of Division 1 and Section 23 05 00 govern work under this section.

1.04 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.05 SUBMITTALS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Contractors shall submit a schedule of all valves indicating type of service, dimensions, and materials of construction, and pressure/temperature ratings for all valves to be used on the project.

- C Temperature ratings specified are for continuous operation.
- D Operation and Maintenance Data:
 - 1. All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.06 DESIGN CRITERIA

- A Where valves are specified for individual mechanical services (i.e. hot water heating, steam, etc.) all valves shall be of the same manufacturer unless prior written approval is obtained from Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Anvil, Apollo, Armstrong, Bell & Gossett, Cash-Acme, Dresser Consolidated, Conval, Crane, Anderson Greenwood and Crosby, Danfoss-Flomatic, DeZurik, Durco, Fisher, Grinnell, Griswold, Hammond, Hancock, Hoffman, Jamesbury, Keystone, Kunkle, Leslie, Lunkenheimer/Cincinnati, Metraflex, Milwaukee, Mueller, Newco, Nexus, Nibco, Powell, RP&C, Sarco, Spence, Stockham, Taco, Tasco, Thrush-Amtrol, Vogt, Watts, or approved equal.

2.02 WATER SYSTEM VALVES

- A All water system valves to be rated at not less than 125 psig water working pressure at 240°F unless noted otherwise.
- B Ball Valves:
 - 1. 2 inch and smaller: Two piece bronze body; threaded or soldered ends, as appropriate to the pipe material; stainless steel or chrome plated brass/bronze ball; conventional port; glass filled teflon seat; threaded packing gland follower; blowout-proof stem; 600 psig WOG.
 - 2. Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.
 - 3. Apollo 70-100/200 series, Hammond 8301/8311, Milwaukee BA100/150, Nibco T/S 585-70, Stockham S206/216.
 - 4. 2-1/2 inch and over: Ball valves will not be accepted in sizes over 2 inch.
- C Butterfly Valves:
 - 1. 2 inches and smaller: Use ball valves; butterfly valves will not be accepted in sizes 2 inch and smaller.
 - 2. 2-1/2 inches and larger: Cast iron body; stainless steel shaft; Teflon, nylatron, or acetal bearings; EPDM resilient seat. Disk to be bronze, aluminum-bronze, nickel plated ductile iron, cast iron with welded nickel edge, or stainless steel. Pressure rated to 150 psig. Valve assembly to be bi-directionally bubble tight to 150 psig with no downstream flange/pipe attached. Polymid or polyamide coated valves are not acceptable.
 - 3. Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.
 - 4. Use threaded lug type valves for installation with class 125/150 flanges.
 - 5. Centerline series 200, DeZurik BGS II, Keystone Fig. 222, Nibco LD2000 (2-1/2"-12")/LD1000 (14" and above), Victaulic 300 series (2-1/2"-12")/709 series (14"-24").
 - 6. Provide ten-position lever actuators for valves 6 inches and smaller. Provide worm gear operators for valves 8 inch and larger.
 - 7. Where butterfly valves are indicated or specified to be installed at the location of a flow sensing device, provide the butterfly valves with a memory stop.

- D Globe Valves:
1. Do not use globe valves for water service, except in temperature control applications.
- E Spring Loaded Check Valves:
1. 2 inch and smaller: Class 125, bronze body, threaded, solder or wafer ends, bronze trim, stainless steel spring, teflon seat unless only bronze available.
 2. APCO 300 series, ConBraCo 61 series, Mueller 303BP, Nibco T-480-Y/S-480-Y, Val-Matic 1400 series.
 3. 2-1/2 inch and larger: Class 125, cast iron or semi-steel body, wafer or globe flanged type, bronze trim, bronze or EPDM seat, stainless steel spring, stainless steel stem if stem is required. Valves with ductile iron in contact with the working fluid will not be accepted.
 4. APCO 600 series, Metraflex 900 series, Milwaukee 1800 series, Mueller Steam 101M-AP/105M-AP, Nibco F910 series, Val-Matic 1800 series, Victaulic series 716.
- F Balance Valves:
1. 2 inch and smaller: Bronze or copper alloy body with calibrated ball, globe or venturi/valve arrangement, integral pointer and calibrated scale to register degree of valve opening, memory stop, drain tapping, threaded or soldered ends, with or without integral unions, P/T or Shraeder pressure taps with integral check valves and seals, adjustable memory stop, suitable for 200 psig water working pressure at 250°F.
 2. Armstrong CBV, Bell & Gossett Circuit Setter Plus, Griswold Quickset, Nexus Orturi, Nibco 1710 Series, Taco Accu-Flo, Tour & Anderson STAS/STAD, Victaulic series 786/787.
 3. Include one bellows type differential pressure meter kit that includes a six inch diameter gauge with 270° arc readout and having an accuracy of ±1% of full scale or better and suitable for the differential pressures of the valves supplied for this project, over-range protection, color coded hoses not less than ten feet in length with brass connectors suitable for connection to the low and high pressure connections on the balance valves, instrument valving so meter can be vented and drained, pressure and temperature rating at least equal to that of the valves. Provide meter and all accessories in a durable case with carrying handle.
 4. Barton 247A, Midwest 809.
 5. 2-1/2 inch and larger: Use butterfly valves as specified in this section along with a flow sensing device as specified in Section 23 05 15.
- G Drain Valves:
1. Use 3/4 inch ball valve with threaded hose adapter except strainer blowdown valves to be the same size as the blowdown connection.
- H Combination Shut-Off, Check, And Balance Valves:
1. 2 inch and larger: Cast or ductile iron body, threaded or flanged or grooved end connections, stainless steel spring, bronze disc with EPDM seat, calibrated memory stop, backseating valve stem, inlet and outlet pressure tappings, capable of being repacked under full line pressure, and suitable for a minimum working pressure of 175 psig at 240°F when used in hot water heating systems.
 2. Armstrong Flo-Trex, Bell & Gossett Triple Duty, Taco Multi-Purpose Valve, Thrush-Amtrol Tri-Flow.

PART 3 EXECUTION

3.01 GENERAL

- A Properly align piping before installation of valves in an upright position; operators installed below the valves will not be accepted.

- B Install valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends.
- C Install all temperature control valves.
- D Install all valves with the stem in the upright position. Valves may be installed with the stem in the horizontal position only where space limitations do not allow installation in an upright position or where large valves are provided with chain wheel operators. Where valves 2-1/2 inch and larger are located more than 12'-0" above mechanical room floors, install valve with stem in the horizontal position and provide a chain wheel operator. Valves installed with the stems down, will not be accepted.
- E Install stem extensions when shipped loose from valve.
- F Prior to flushing of piping systems, place all valves in the full-open position.

3.02 SHUT-OFF VALVES

- A Install shut-off valves at all equipment, at each branch take-off from mains, and at each automatic valve for isolation or repair.
- B Water System:
 - 1. Butterfly valves installed at the location of a flow sensing device are to have a memory stop.

3.03 BALANCING VALVES

- A Provide balancing valves for all major equipment and at each major branch takeoff and at the discharge of each pump as indicated on drawings and details.
- B Calibrated Balance Valves:
 - 1. Install where indicated on the drawings and details for balancing of hydronic systems. Retain the shipping container for use as removable insulation.

3.04 DRAIN VALVES

- A Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping systems, equipment locations specified or detailed including reheat coils, other locations required for drainage of systems.

3.05 SPRING LOADED CHECK VALVES

- A Install a spring loaded check valve in each pump discharge line where two pumps operate in parallel and no combination shutoff, check and balancing valve is being used.

3.06 COMBINATION SHUT-OFF, CHECK, AND BALANCING VALVES

- A Contractor may use combination shut-off, check and balancing valves where separate shut-off valve, check valve, and balancing valve are specified or detailed in pump discharge piping.

END OF SECTION 23 05 23

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for supports of all HVAC equipment and materials as well as piping system anchors. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Description.
 - g. Shop Drawings.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Pipe Hanger and Support Manufacturers.
 - b. Structural Supports.
 - c. Pipe Hangers and Supports.
 - d. Beam Clamps.
 - e. Concrete Inserts.
 - f. Anchors.
 - g. Roof Mounted Supports.
 - h. Equipment Curbs.
 - i. Pipe Penetrations through Roof.
 - j. Corrosive Atmosphere Coatings.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Hanger and Support Spacing.
 - c. Vertical Riser Clamps.
 - d. Anchors.
 - e. Roof Mounted Supports.
 - f. Equipment Curbs.
 - g. Pipe Penetration through Roof.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
C Section 23 07 00 - HVAC Insulation.

1.03 REFERENCE

- A Applicable provisions of Division 1 shall govern work under this section.

1.04 REFERENCE STANDARDS

- A MSS SP-58 Pipe Hangers and Supports - Materials, Design and Manufacture.

- B MSS SP-59 Pipe Hangers and Supports - Selection and Application.

1.05 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.06 DESCRIPTION

- A Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for pressure piping.
- B Do not hang any mechanical item directly from a metal deck or run piping so it rests on the bottom chord of any truss or joist.
- C Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.
- D Protect insulation at all hanger points; see Related Work above.

1.07 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Schedule of all hanger and support devices indicating shields, attachment methods, and type of device for each pipe size and type of service. Reference section 23 05 00.
- C All submittals are to comply with submission and content requirements specified in specification Section 01 91 01 - Commissioning Process.

1.08 DESIGN CRITERIA

- A Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.
- B Piping connected to base mounted pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.
- C Piping flexible connections and vibration isolation supports are required for piping connected to coils that are in a fan assembly where the entire assembly is mounted on vibration supports; the vibration isolation supports are required for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Piping flexible connection and vibration isolation supports are not required when the fan section is separately and independently isolated by means of vibration supports and duct flexible connections. Standard pipe hangers/supports as specified in this section are required when there are no vibration isolation devices in the piping and beyond the 100 pipe diameter/3 support distance.
- D Piping supported by laying on the bottom chord of joists or trusses will not be accepted.
- E Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.
- F Allow sufficient space between adjacent pipes and ducts for insulation, valve operation, routine maintenance, etc.

PART 2 PRODUCTS

2.01 PIPE HANGER AND SUPPORT MANUFACTURERS

- A Anvil, B-Line, Fee and Mason, Kindorf, Michigan Hanger, Unistrut, or approved equal. Anvil figure numbers are listed below; equivalent material by other manufacturers is acceptable.

2.02 STRUCTURAL SUPPORTS

- A Provide all supporting steel required for the installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support tanks and equipment.

2.03 PIPE HANGERS AND SUPPORTS

- A Hangers For Steel Pipe Sizes 1/2" Through 2":
 - 1. Carbon steel, adjustable, clevis, black finish. Anvil figure 65 or 260.
- B Hangers For Steel Pipe Sizes 2-1/2" And Over:
 - 1. Carbon steel, adjustable, clevis, black finish. Anvil figure 260.
- C Adjustable steel yoke, cast iron roll, double hanger. Anvil figure 181.
- D Multiple or Trapeze Hangers:
 - 1. Steel channels with welded spacers and hanger rods if calculations are submitted.
- E Wall Support:
 - 1. Welded steel bracket with hanger. B-Line 3068 Series, Anvil 194 Series.
 - 2. Perforated epoxy painted finish, 16-12 gauge min., steel channels securely anchored to wall structure with interlocking, split type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Anvil type AS200 H with AS 1200 clamps. When copper piping is being supported, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Anvil cushion clamp assembly.
- F Vertical Riser Support:
 - 1. Carbon steel riser clamp, copper plated when used with copper pipe. Anvil figure 261 for steel pipe, figure CT121 for copper pipe.
- G Floor Support for Pipe Sizes through 4":
 - 1. Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- H Floor Support for Pipe Sizes 5" and Over:
 - 1. Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- I Copper Pipe Support:
 - 1. Carbon steel ring, adjustable, copper plated or polyvinylchloride coated.
- J Insulation Protection Shields:
 - 1. Galvanized carbon steel of not less than 18 gauge for use on insulated pipe 2-1/2 inch and larger. Minimum shield length is 12 inches. Equal to Anvil figure 167.
- K Steel Hanger Rods:
 - 1. Threaded both ends, threaded one end, or continuous threaded, black finish.
 - 2. Size rods for individual hangers and trapeze support as indicated in the following schedule.
 - 3. Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2
1810	5/8
2710	3/4

3770	7/8
4960	1
8000	1-1/4

4. Provide rods complete with adjusting and lock nuts.

2.04 BEAM CLAMPS

- A MSS SP-69 Type 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick for single threaded rods of 3/8, 1/2, and 5/8 inch diameter, for use with pipe sizes 4 inch and less. Furnish with a hardened steel cup point set screw. Anvil figure 86.
- B MSS SP-69 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter but limited in application to pipe sizes 8 inch and less without prior approval. Anvil figure 228.

2.05 CONCRETE INSERTS

- A Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor. Hilti, Rawl, Redhead.

2.06 ANCHORS

- A Use welding steel shapes, plates, and bars to secure piping to the structure.

2.07 ROOF MOUNTED SUPPORTS

- A Height of Supports:
 1. Based on the length of the longest main support member, the height of the support member above the roof deck to be as follows:

Length of Longest Support Member (inches)	Min. Height of Support Above Finished Roof
Up to 36"	18 inches
37" and Over	36 inches

- B Supports 18" Or Less In Height:
 1. Prefabricated Metal Sleeper Curb:
 - a. Constructed of not less than 18 gauge galvanized steel reinforced so it is structurally capable of supporting the intended load with no penetrations through the curb flashing, inside and outside corner sections that are mitered and continuously welded, filled with 3 pound density rigid fiberglass insulation, integral deck mounting flange, nominal two inch wood nailer, galvanized steel counter flashing with metal receiver cap Attach a galvanized steel channel track for securing pipe or duct roller and roller support. Do not use built-in metal base flashings or cants.
 2. Wood Build Sleeper Curb:
 - a. Constructed of wood blocking anchored to the deck. The curb must be structurally capable of supporting the intended load with no penetrations through the curb flashing. Galvanized steel counter flashing with metal receiver cap. Attach a steel channel track for securing pipe or duct roller support. Do not use built-in metal base flashings or cants.
- C Use galvanized structural steel members supported by pipe supports and use pipe or duct rollers fastened to the structural member. Pipe supports to be secured to the roof structure and sealed per pipe penetrations through roof specifications as specified in this section.

D Supports 36" or More In Height:

1. Roof Support Stand/Equipment Roof Support Stand:
 - a. Use galvanized structural steel members supported by pipe supports and use pipe or duct rollers fastened to the structural member. Pipe supports to be secured to the roof structure and sealed per pipe penetrations through roof specifications as specified in this section.

2.08 EQUIPMENT CURBS

A Prefabricated Metal Curb:

1. Constructed of not less than 18 gauge galvanized steel reinforced so it is structurally capable of supporting the intended load with no penetrations through the curb flashing, inside and outside corner sections that are mitered and continuously welded, filled with 3 pound density rigid fiberglass insulation, integral deck mounting flange, nominal two inch wood nailer, galvanized steel counter flashing. Do not use built-in metal base flashings or cants. Use 18 inch high equipment curbs where the curb completely surrounds the perimeter of the equipment and there is no roof exposed to the weather.

B Wood Build Sleeper Curb:

1. Constructed of wood blocking and anchored to the deck. The curb must be structurally capable of supporting the intended load with no penetrations through the curb flashing. Galvanized steel counter flashing. Do not use built-in metal base flashings or cants. Use 18 inch high equipment curbs where the curb completely surrounds the perimeter of the equipment and there is no roof exposed to the weather.

2.09 PIPE PENETRATIONS THROUGH ROOF

A Multiple Pipe Penetrations:

1. Refer to acceptable Equipment Curb types listed above for curb specifications. An 8" high (minimum) curb height is required. The coping cap shall be constructed from laminated acrylic clad thermoplastic (ABS) with graduated step boots to accommodate various size pipes, stainless steel fastening screws for cover, stainless steel band clamps for securing boots around the pipe, and stainless steel band clamp or mechanical locking seal for securing boots around the ABS coping cap flanges.

B Single Pipe Penetrations:

1. A stack flashing penetration may be utilized for single pipe penetrations through built up roofs and single ply membrane roofs. Utilize high temperature sealant for all high temperature applications. This includes but is not limited to steam condensate vent piping, steam safety relief piping, and flues.
2. A single pre-manufactured boot may be utilized for single pipe penetrations through single ply membrane roofs only.

2.10 CORROSIVE ATMOSPHERE COATINGS

- A Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication, ASTM A123, 1.5 ounces/square foot of surface, each side. Mechanical galvanize threaded products, ASTM B695 Class 150, 2.0 mil coating. Field cuts and damaged finishes to be field covered with zinc rich paint of comparable thickness to factory coating.

B Corrosive atmospheres include the following locations:

1. Exterior locations.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install supports to provide for free expansion of the piping and duct system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.
- B Piping shall be supported independently from ductwork and all other trades.
- C Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes for the supporting steel.
- D Perform all welding in accordance with standards of the American Welding Society. Clean surfaces of loose scale, rust, paint or other foreign matter and properly align before welding. Use wire brush on welds after welding. Welds shall show uniform section, smoothness of weld metal and freedom from porosity and clinkers. Where necessary to achieve smooth connections, joints shall be dressed smooth.

3.02 HANGER AND SUPPORT SPACING

- A Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item.
- B Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.
- C Support riser piping independently of connected horizontal piping.
- D Adjust hangers to obtain the slope specified in the piping section of this specification.
- E Space hangers for pipe as follows:

<u>Pipe Material</u>	<u>Pipe Size</u>	<u>Max. Spacing</u>
Steel	1/2" through 1-1/4"	6'-6"
Steel	1-1/2" through 6"	10'-0"
Steel	8" through 12"	14'-0"
Steel	14" and over	20'-0"
Thermoplastic	All sizes	6'-0"
Copper	1/2" through 1-1/4"	5'-0"
Copper	1-1/2" and larger	8'-0"

3.03 VERTICAL RISER CLAMPS

- A Support vertical piping with clamps secured to the piping and resting on the building structure or secured to the building structure below at each floor.

3.04 ANCHORS

- A Install where indicated on the drawings and details. Where not specifically indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.05 ROOF MOUNTED SUPPORTS

- A Use for all pipe and ductwork on roof. Secure bottom of support flat on roof deck. Apply two coats of zinc rich paint to cut edges of all galvanized steel elements. Flashing and counter flashing by the General Contractor.

3.06 EQUIPMENT CURBS

- A Secure bottom of support flat on roof deck. Secure equipment to curb in accordance with equipment manufacturer's instructions. Flashing and counter flashing by the General Contractor.
- B Fill the entire void space with compressible fiberglass insulation.

3.07 PIPE PENETRATION THROUGH ROOF

- A Install at points where pipes penetrate roof. Install as shown on the drawings, as detailed and according to the manufacturer's installation instructions. Flashing and counter flashing by the General Contractor.

END OF SECTION 23 05 29

INTENTIONALLY LEFT BLANK

SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for vibration isolation material for equipment, piping systems, and duct systems. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Quality Assurance.
 - e. Design Criteria.
 - f. Shop Drawings.
 2. PART 2 – PRODUCTS.
 - a. Materials.
 - b. Vibration Isolation Manufacturers.
 - c. Type 1: Neoprene Pad.
 - d. Type 2: Neoprene Pad.
 - e. Type 3: Unhoused Spring with Neoprene.
 - f. Type 4: Restrained Spring with Neoprene.
 - g. Type 5: Spring Hanger with Neoprene.
 - h. Type 6: Precompressed Spring Hanger with Neoprene.
 - i. Type 7: Spring Hanger with Neoprene.
 - j. Type S: Steel Base.
 - k. Type T: Horizontal Thrust Restraint.
 - l. Flexible Piping Connections.
 - m. Performance.
 - n. Blower Minimum Deflection Guide.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Packaged Air Handling Units and Centrifugal Fans.
 - c. Isolation Devices Outdoors or in High Humidity Areas.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
C Section 23 21 23 - Hydronic Pumps.
D Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units.
E Section 23 34 00 - HVAC Fans.
F Section 23 33 00 - Air Duct Accessories.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.05 DESIGN CRITERIA

- A Isolate all motor driven mechanical equipment from the building structure and from the systems which they serve to prevent equipment vibrations from being transmitted to the structure. Consider equipment weight distribution to provide uniform isolator deflections.
- B For equipment with variable speed capability, select vibration isolation devices based on the lowest speed.
- C Provide flexible piping connections for all piping to rotating or reciprocating equipment mounted on vibration isolators except do not use flexible piping connectors on any type of gas piping or with inline pumps. Piping connected to a coil which is in an assembly mounted on vibration isolators is to have flexible piping connections and piping vibration hangers as specified below. Piping connected to a coil which is in an assembly where the fan is separately isolated by means of vibration isolators and duct flexible connections does not require flexible piping connectors or piping vibration hangers.
- D Credit will be given for the inherent flexibility and vibration absorption characteristics of mechanical grooved pipe connections providing that supporting calculations are submitted for approval.
- E Coordinate the selection of devices with the isolator and equipment manufacturers.

1.06 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Include isolator type, materials of construction, isolator free and operating heights, and isolation efficiency based on the lowest operating speed of the equipment supported.

PART 2 PRODUCTS

2.01 MATERIALS

- A Use materials that will retain their isolation characteristics for the life of the equipment served. Use industrial grade neoprene for elastomeric materials.
- B Treat all isolators to resist corrosion. For isolation devices exposed to the weather or used in high humidity areas, hot dip galvanize steel parts, apply a neoprene coating on all steel parts, or use stainless steel parts; include limit stops to resist wind.
- C Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.
- D Use isolators with a ratio of lateral to vertical stiffness not less than 1.0 or greater than 2.0.

2.02 VIBRATION ISOLATOR MANUFACTURERS

- A Mason Industries, Amber/Booth Co., Vibration Mounting & Controls, Peabody Noise Control, Vibration Eliminator or approved equal.

2.03 TYPE 1: NEOPRENE PAD

- A Neoprene waffle pad, 40 durometer with 16 gauge shims between layers.

2.04 TYPE 2: NEOPRENE PAD

- A Double deflection neoprene mount having a minimum static deflection of 0.35 inches. Cover all metal surfaces with neoprene to resist corrosion. Include friction pads on both top and bottom surfaces so mounts need not be bolted to the floor but include bolt holes for those areas where bolting is required. For equipment such as small vent sets and close coupled pumps, include steel rails for use between the isolator and the equipment to accommodate equipment overhang.

2.05 TYPE 3: UNHOUSED SPRING WITH NEOPRENE

- A Combination freestanding, unhooused spring and neoprene with rib molded antifricition base. Include leveling bolts for securing to the equipment.

- B Springs to be laterally stable under load and selected so they have an additional travel to solid equal to 50% of the rated deflection. Use height saving brackets when appropriate to the application.

2.06 TYPE 4: RESTRAINED SPRING WITH NEOPRENE

- A Combination spring and neoprene with rib molded base similar to Type 3 mount above, but with a housing that includes vertical limit stops to prevent spring extension when weight is removed such that the installed and operating heights are the same. Maintain a minimum clearance of 1/2 inch around restraining bolts, and between the housing and the spring, so as not to interfere with the spring action. Design isolator so limit stops are out of contact during normal operation. Use height saving brackets when appropriate to the application.

2.07 TYPE 5: SPRING HANGER WITH NEOPRENE

- A Vibration hanger with a steel spring and 0.3 inch deflection neoprene element in series. Use neoprene element molded with a rod isolation bushing that passes through the hanger box. Select spring diameters and size hanger box lower holes large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Select springs so they have a minimum additional travel to solid equal to 50% of the rated deflection.

2.08 TYPE 6: PRECOMPRESSED SPRING HANGER WITH NEOPRENE

- A Vibration hanger similar to Type 5 but precompressed to the rated deflection to keep the piping or equipment at a fixed elevation during installation. Design hanger with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load.

2.09 TYPE 7: SPRING HANGER WITH NEOPRENE

- A Steel spring hanger located in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. Neoprene cup to contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Design spring diameter and size hanger box lower hole sufficiently large to permit the hanger rod to swing through a 30° arc before contacting the hole perimeter and short circuiting the spring. Select spring so it has a minimum additional travel to solid equal to 50% of the rated deflection. Provide hanger with an eye bolt on the spring end and provision to attach the housing to the flat iron duct straps.

2.10 TYPE S: STEEL BASE

- A Structural steel base, rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be "T" or "L" shaped. Include support for suction and discharge base ells for split case pump bases. Use perimeter steel members with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14 inch provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Use height saving brackets in all mounting locations to provide a base clearance of at least one inch above the floor or housekeeping pad.

2.11 TYPE T: HORIZONTAL THRUST RESTRAINT

- A Spring element in series with a neoprene pad as described for Type 3 mount with the same deflection as specified for the mounting or hanger. Design the assembly so the spring element is contained within a steel frame, so it can be preset for thrust at the factory and adjusted in the field for a maximum of 1/4 inch movement at start and stop. Include threaded rod and angle brackets for attachment to both equipment and ductwork or equipment and structure.

2.12 FLEXIBLE PIPING CONNECTIONS

- A Suitable for pressure, temperature, and fluid involved; minimum pressure rating for any system is 125 psig at the design temperature of the fluid. Use 12 inch minimum line length of flexible hose or length required to absorb 3/4 inch lateral movement, whichever is greater.

B Manufacturers:

1. Flexonics, Mason, Mercer Rubber, Metraflex, Engineered Flexible Products or approved equal.

C Water and/or Pumped Condensate:

1. Multiple plies of nylon tire cord fabric reinforced with an EPDM cover and liner. Do not use steel wire or rings as pressure reinforcement. Use threaded or soldered connections for sizes 2 inch and smaller and floating steel or ductile iron flanges for sizes 2-1/2 inch and larger; design the steel flange end so the steel flange is recessed to lock a steel wire bead ring in the raised face of the EPDM flange. Construct straight-through connections with twin spheres. Use control rods when recommended by the manufacturer.

D Refrigerant:

1. Seamless bronze corrugated flexible hose with bronze wire braided cover and solder type copper tube ends with the entire assembly fabricated specifically for refrigerant duty.

2.13 PERFORMANCE

- A Select vibration isolation devices as indicated below or to provide not less than 95% isolation efficiency, whichever is greater.

TYPE OF EQUIPMENT	----- Floor Span or Column Spacing-----							
	--On Grade--		---20 Feet---		---30 Feet---		---40 Feet---	
	Iso. Type	Min. Static Defl. In.	Iso. Type	Min. Static Defl. In.	Iso. Type	Min. Static Defl. In.	Iso. Type	Min. Static Defl. In.
AIR-COOLED								
CONDENSING UNITS:	Bolt to pad		3	0.75	4	1.50	4	2.50
PACKAGED								
AIR HANDLING UNITS:								
Floor mounted								
Thru 5 hp	3	0.35	3	0.75	3	0.75	3	0.75
7-1/2 hp and over								
Thru 400 rpm	3	0.35	3-S	1.50	3-S	1.50	3-S	1.50
7-1/2 hp thru 40 hp								
401 rpm and over	3	0.35	3	0.75	3	0.75	3-S	1.50
CENTRIFUGAL BLOWERS								
Suspended								
	Use type 5-T hangers with deflection from blower minimum deflection guide. Type T needed only when air thrust exceeds 10% of equipment weight.							
Floor mounted								
	Use type 3-IB mount with deflection from blower minimum deflection guide.							

CABINET FANS
AND FAN SECTIONS
OF AIR HANDLING UNITS:
Suspended

Type 5-T supports with deflection from blower minimum deflection guide.
Type T needed only when air thrust exceeds 10% of equipment weight.

Floor mounted

Type 2-T for 0.35" deflection, type 3-T for 0.75" deflections and type 3-S-T for deflections over 0.75" with deflection from blower minimum deflection guide.

PIPING CONNECTED TO
ROTATING OR
RECIPROCATING
EQUIPMENT:

Flexible piping connections and type 5 or 6 hangers for a distance of 100 pipe diameters or a distance of three hangers away from the equipment, whichever is greater. Type 6 hangers shall be utilized for the first two upstream and downstream hangers. The Type 5 and/or type 6 hangers must have the same deflection as the hangers supporting the rotating or reciprocating equipment. Where piping is floor supported, the above requirements apply, but use type 3 mounts instead of type 5 or 6 hangers.

DUCTWORK IN
MECHANICAL EQUIPMENT
ROOMS:

Use type 7 hanger with .75" minimum deflection for all ducts with a cross sectional area greater than 2.0 square feet and, where either the air velocity is greater than 3500 fpm or, the pressure class is 4" water column or higher.

2.14 BLOWER MINIMUM DEFLECTION GUIDE

		-----Required Deflection (Inches)-----			
Fan Speed (RPM) Grade		On	20'	30'	40'
		Floor Span	Floor Span	Floor Span	Floor Span
175-224	0.35	3.50	4.50	4.50	
225-299	0.35	3.50	3.50	3.50	
300-374	0.35	2.50	2.50	3.50	
375-499	0.35	1.50	2.50	3.50	
500 and over	0.35	0.75	1.50	2.50	

PART 3 EXECUTION

3.01 INSTALLATION

- A Install vibration isolation devices for motor driven equipment in accordance with the manufacturer's installation instructions.

- B Set steel and inertia bases for one inch clearance between the concrete floor or housekeeping pad and the base.
- C Do not allow installation practices to short circuit any isolation device.
- D Install flexible piping connections on the equipment side of shut-off valves.

3.02 PACKAGED AIR HANDLING UNITS AND CENTRIFUGAL FANS

- A Attach horizontal thrust restraints at the centerline of thrust and symmetrically on either side of the unit. Thrust restraints are not required when the fan section is not isolated from the remainder of the air handling unit by means of duct flexible connections.

3.03 ISOLATION DEVICES OUTDOORS OR IN HIGH HUMIDITY AREAS

- A Use only hot dip galvanized, stainless steel, or neoprene coated steel parts.

END OF SECTION 23 05 48

SECTION 23 05 93
TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SCOPE

- A This section includes air and water testing, adjusting and balancing for the entire project. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Description.
 - f. Quality Assurance.
 - g. Approved Contractors.
 - h. Pre-Installation Meeting and Scheduling.
 - i. Pre-Balance Conference.
 - j. Submittals.
 2. PART 2 – PRODUCTS.
 - a. Instrumentation.
 3. PART 3 – EXECUTION.
 - a. Daily Reports.
 - b. Preliminary Procedures.
 - c. Performing Testing, Adjusting and Balancing.
 - d. VAV Supply and Exhaust Duct System Static Pressure Set Point.
 - e. Hydronic System Differential Pressure Control Set Point.
 - f. Deficiencies.
 - g. Functional Performance Testing.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 00 - Common Work Results for HVAC.
C Section 23 07 00 - HVAC Insulation.
D Section 23 09 13 - Instrumentation and Control Devices for HVAC.
E Section 23 09 23 - Direct Digital Control System for HVAC.

1.03 REFERENCE

- A Applicable provisions of the General Conditions, Supplementary General Conditions and General Requirements in Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A AABC National Standards for Total System Balance, Sixth Edition, 2002.
B ASHRAE ASHRAE Handbook, 2007 HVAC Applications, Chapter 37, Testing Adjusting and Balancing.

- C NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems, Seventh Edition, 2005.

1.05 DESCRIPTION

- A The Contractor will separately contract with an independent test and balance agency to perform all testing, adjusting, and balancing of air and hydronic systems required for this project. Work related to the testing, adjusting, and balancing that must be performed by the installing mechanical Contractor is specified in other section of these specifications.
- B Provide total mechanical systems testing, adjusting and balancing. Requirements include the balance of air and water distribution, adjustment of new and existing systems and equipment to provide design requirements indicated on the drawings, electrical measurement and verification of performance of all mechanical equipment, all in accordance with standards published by AABC or NEBB.
- C Test, adjust and balance all air and hydronic systems so that each room, piece of equipment or terminal device meets the design requirements indicated on the drawings and in the specifications.
- D Accomplish testing, adjusting and balancing work in a timely manner that allows partial occupancy of major buildings, occupancy of one building when the project involves many buildings, and completion of the entire project in the time stated in the Instruction to Bidders and in accordance with the completion schedule established for this project.
- E Verify that provisions are being made to accomplish the specified testing, adjusting and balancing work. If problems are found, handle as specified in Part 3 under Deficiencies.

1.06 QUALITY ASSURANCE

- A Qualifications:
1. An independent Firm specializing in the Testing and Balancing of HVAC systems for a minimum of 3 years. A Firm not engaged in the commerce of furnishing or providing equipment or material generally related to HVAC work other than that specifically related to installing Testing and Balancing components necessary for work in this section such as, but not limited to sheaves, pulleys, and balancing dampers.
 2. A certified member of AABC or certified by NEBB in the specific area of work performed. Maintain certification for the entire duration of the project. If certification of firm or any staff performing work is terminated or expires during the duration of the project, contact Owner immediately.
 3. Technicians on this project must have satisfactorily completed work on a minimum of (3) three projects of at least 50% in size, and of similar complexity.
 4. Submit Qualifications of firm and project staff to Owner upon request.

1.07 APPROVED CONTRACTORS

- A T&B Contractors.
- B T&B Services, Ltd: www.tbservicesltd.net.
- C Badger Balancing, LLC: www.badgerbalancing.com.

1.08 PRE-INSTALLATION MEETING AND SCHEDULING

- A The test and balance agency is required to attend a pre-installation meeting with all other project Contractors before the construction process is started. The test and balance agency shall give the Lead Contractor a detailed schedule of testing and balancing tasks for incorporation into the project schedule. Reference General Conditions Article 12 for Lead Contractor responsibilities for scheduling.

1.09 PRE-BALANCE CONFERENCE

- A 90 days prior to beginning testing, adjusting and balancing, schedule and conduct a conference with the Engineer, Owner's Project Representative and the mechanical system and temperature control system installing Contractors. Provide Engineer and Commissioning Provider (CxP) with a complete copy of the TAB plan for the project. The objective is final coordination and verification of system operation and readiness for testing, adjusting and balancing procedures and scheduling procedures with the above mentioned parties. Indicate work required to be completed prior to testing, adjusting, and balancing and identify the party responsible for completion of that work.

1.10 SUBMITTALS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures. See also Related Work in this section.
- B Submit testing, adjusting and balancing reports bearing the seal and signature of the NEBB or AABC Certified Test and Balance Supervisor. The reports certify that the systems have been tested, adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed and are operating; and are an accurate record of all final quantities measured to establish normal operating values of the systems.
- C Submission:
 - 1. Distribute electronic copies of the Report to the Contractor, the Lead Contractor, the Owner, and the Prime Engineer.
- D Enter a RFI, with a copy of the Testing and Balancing Report Summary as an upload, indicating that the Testing and Balancing Report is posted on the Overview page and requesting review of the report.
 - 1. Format: Cover page identifying project name, project number and descriptive title of contents. Divide the contents of the report into the below listed divisions:
 - a. General Information.
 - b. Summary.
 - c. Air Systems.
 - d. Hydronic Systems.
 - e. Special Systems.
 - 2. Contents: Provide the following minimum information, forms and data:
 - a. General Information: Inside cover sheet identifying Test and Balance Agency, Contractor, Architect, Engineer, Project Name and Project Number. Include addresses, contact names and telephone numbers. Also include a certification sheet containing the seal and signature of the Test and Balance Supervisor.
 - b. Summary: Provide summary sheet describing mechanical system deficiencies. Describe objectionable noise or drafts found during testing, adjusting and balancing. Provide recommendations for correcting unsatisfactory performances and indicate whether modifications required are within the scope of the contract, are design related or installation related. List instrumentation used during testing, adjusting and balancing procedures.
 - c. The remainder of the report to contain the appropriate standard NEBB or AABC forms for each respective item and system. Fill out forms completely. Where information cannot be obtained or is not applicable indicate same.

PART 2 PRODUCTS

2.01 INSTRUMENTATION

- A Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements to be in accordance with the requirements of NEBB or AABC Standards and instrument manufacturer's specifications.
- B All instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by Owner upon request. Calibration and maintenance of all instruments to be in accordance with the requirements of NEBB or AABC Standards

PART 3 EXECUTION

3.01 DAILY REPORTS

- A Submit to Owner's Project Representative daily work activity reports for each day on which testing and balancing work is performed. Reports shall include description of day's activities and description of any system deficiencies.

3.02 PRELIMINARY PROCEDURES

- A Review preconstruction meeting report, applicable construction bulletins, applicable change orders and approved shop drawings of equipment, outlets/inlets and temperature controls.
- B Check filters for cleanliness, dampers and valves for correct positioning, equipment for proper rotation and belt tension, temperature controls for completion of installation and hydronic systems for proper charge and purging of air.
- C Notify Owner's Project Representative on a daily basis during balancing. Identify deficiencies preventing completion of testing, adjusting and balancing procedures. Do not proceed until systems are fully operational with all components necessary for complete testing, adjusting and balancing. Installing Contractors are required to provide personnel to check and verify system completion, readiness for balancing and assist Balancing Agency in providing specified system performance.

3.03 PERFORMING TESTING, ADJUSTING AND BALANCING

- A Perform testing, adjusting and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards except as may be modified below.
- B Unless specifically instructed in writing, all work in this specification section is to be performed during the normal workday.
- C In areas containing ceilings, remove ceiling tile to accomplish balancing work; replace tile when work is complete and provide new tile for any tile that are damaged by this procedure. If the ceiling construction is such that access panels are required for the work of this section and the panels have not been provided, inform the Owner's Project Representative.
- D Cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary for adequate performance of procedures. Patch using materials identical to those removed, maintaining vapor barrier integrity and pressure rating of systems.
- E In air systems employing filters, blank off sufficient filter area to simulate a pressure drop that is midway between that of a clean filter and that of a dirty filter.
- F Measure and record system measurements at the fan and/or pump to determine total flow. Adjust equipment as required to yield specified total flow at terminals. Proceed taking measurements in mains and branches as required for final terminal balancing. Perform terminal balancing to specified flows balancing branch dampers, deflectors, extractors and valves prior to adjustment of terminals.
- G Measure and record static air pressure conditions across fans, coils and filters. Indicate in report if cooling coil measurements were made on a wet or dry coil and if filter measurements were made on a clean or dirty filter. Spot check static air pressure conditions directly ahead of terminal units.

- H Adjust outside air, return air and relief air dampers for design conditions at both the minimum and maximum settings and record both sets of data. Balance modulating dampers at extreme conditions and record both sets of data. Balance variable air volume systems at maximum air flow rate, full cooling, and minimum flow rate, full heating; record all data.
- I Adjust register, grille and diffuser vanes and accessories to achieve proper air distribution patterns and uniform space temperatures free from objectionable noise and drafts within the capabilities of the installed system.
- J Provide fan and motor drive sheave adjustments necessary to obtain design performance. Provide drive changes specifically noted on drawings, if any. If work of this section indicates that any drive or motor is inadequate for the application, advise the Owner's project representative by giving the representative properly sized motor/drive information (in accordance with manufacturers original service factor and installed motor horsepower requirements); Confirm any change will keep the duct/piping system within its design limitations with respect to speed of the device and pressure classification of the distribution system. Required motor/drive changes not specifically noted on drawings or in specifications will be considered an extra cost and will require an itemized cost breakdown submitted to Owner's project representative. Prior authorization is needed before this work is started.
- K Areas or rooms designed to maintain positive, negative or balanced air pressures with respect to adjacent spaces, as indicated by the design air quantities, require special attention. Adjust fan drives, distribution dampers, terminals and controls to maintain indicated pressure relationship.
- L Final air system measurements to be within the following range of specified cfm:
 - 1. Fans 0% to +10%.
 - 2. Supply grilles, registers, diffusers 0% to +10%.
 - 3. Return/exhaust grilles, registers 0% to -10%.
- M Final water system measurements must be within the following range of specified gpm:
 - 1. Heating flow rates 0% to -10%.
- N Contact the temperature control Contractor for assistance in operation and adjustment of controls during testing, adjusting and balancing procedures. Cycle controls and verify proper operation and setpoints. Include in report description of temperature control operation and any deficiencies found.
- O Permanently mark equipment settings, including damper and valve positions, control settings, and similar devices allowing settings to be restored. Set and lock memory stops.
- P Leave systems in proper working order, replacing belt guards, closing access doors and electrical boxes, and restoring temperature controls to normal operating settings.
- Q Coordinate and assist CxP with all verification activities defined within section 01 91 01 including providing all required sampling data necessary for the commissioning process.
- R Verify and record, in the T&B Report, "K" factors for all VAV air terminal devices and air flow stations.
- S Coordinate air handling unit minimum outside air set points with the Temperature Control Contractor.

3.04 VAV SUPPLY AND EXHAUST DUCT SYSTEM STATIC PRESSURE SET POINT

- A For VAV supply and exhaust systems with VAV air terminal devices, determine the minimum required duct static pressure at the DDC static pressure sensor location(s) needed to ensure that all VAV air terminals are operating at their design airflows with the most demanding VAV terminal wide open. Provide these static pressure numbers to the DDC temperature controls contractor and record them in the T&B report for each system.

3.05 HYDRONIC SYSTEM DIFFERENTIAL PRESSURE CONTROL SET POINT

- A For hydronic systems with variable speed pumping, determine the minimum required system differential pressure set point needed to ensure that all terminal devices are operating at their design water flows with the most demanding terminals device control valve wide open. Provide the differential control setting set point to the DDC temperature control contractor and record them in the T&B report for each system.
- B For HVAC pumps 10 horsepower or less, valve throttling alone may be used for hydronic system balancing.
- C Throttling of triple-duty valves shall not exceed 50% closed. Where additional throttling would be necessary to achieve the system design flow the impellor shall be trimmed.
- D Verify Triple duty valve utilized on systems with Variable Frequency Drives are 100% open when balancing work is complete.
- E The pressure drop across triple duty valves shall not exceed 25 ft. w.g. Where additional throttling would be necessary to achieve the system design flow the impellor shall be trimmed.
- F For HVAC pumps greater than 10 horsepower through 60 horsepower, trim the impellor where valve throttling will result in a draw that exceeds 3 horsepower.
- G For HVAC pumps larger than 60 horsepower, trim the impellor where valve throttling results in a horsepower draw that exceeds 5% of the pump motor horsepower rating.
- H Future fouling of an open piping system may be considered when determining impellor trim requirements.
- I Verify butterfly valves utilized for hydronic system balancing are provided with position-lock operators (memory stops) in accordance with Section 23 05 23. The adjustment and marking of lever-lock operators that use throttling notches will not be accepted. Lock all memory stops so the valves can be reopened to their balanced positions if they are used for isolation purposes.

3.06 DEFICIENCIES

- A Division 23 Contractor to correct any installation deficiencies found by the test and balance agency that were specified and/or shown on the Contract Documents to be performed as part of that division of work. Test and balance agency will notify the Owner's Project Representative of these items and instructions will be issued to the Division 23 Contractor for correction of the deficient work. All corrective work to be done at no cost to the Owner. Retest mechanical systems, equipment, and devices once corrective work is complete as specified.

3.07 FUNCTIONAL PERFORMANCE TESTING

- A Contractor is responsible for performing the functional performance test procedures. Notify the Engineer and commissioning provider 5 business days prior to performing functional performance testing so that they may witness. Reference Section 01 91 01 - Commissioning Process and functional performance test form FPT-23 05 93 for specific requirements.

END OF SECTION 23 05 93

SECTION 23 07 00 HVAC INSULATION

PART 1 GENERAL

1.01 SCOPE

- A This section includes insulation specifications for heating, ventilating and air conditioning piping, ductwork and equipment. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Description.
 - g. Definitions.
 - h. Shop Drawings.
 - i. Operation and Maintenance Data.
 - j. Environmental Requirements.
 2. PART 2 – PRODUCTS.
 - a. Materials.
 - b. Insulation Types.
 - c. Jackets.
 - d. Insulation Inserts and Pipe Shields.
 - e. Expansion Joint and Valve Insulation Blankets.
 - f. Accessories.
 3. PART 3 – EXECUTION.
 - a. Examination.
 - b. Installation.
 - c. Protective Jacket Installation.
 - d. Piping, Valve and Fitting Insulation.
 - e. Piping Protective Jackets.
 - f. Pipe Insulation Schedule.
 - g. Duct Insulation.
 - h. Ductwork Protective Coverings.
 - i. Duct Insulation Schedule.
 - j. Equipment Insulation.
 - k. Equipment Insulation Schedule.
 - l. Construction Verification Items.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 00 - Common Work Results for HVAC.
C Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
D Section 23 21 13 - Hydronic Piping.

E Section 23 31 00 - HVAC Ducts and Casings.

1.03 REFERENCE

A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate.
- B ASTM C165 Test Method for Compressive Properties of Thermal Insulations.
- C ASTM C177 Heat Flux and Thermal Transmission Properties.
- D ASTM C195 Mineral Fiber Thermal Insulation Cement.
- E ASTM C240 Cellular Glass Insulation Block.
- F ASTM C302 Density of Preformed Pipe Insulation.
- G ASTM C303 Density of Preformed Block Insulation.
- H ASTM C355 Test Methods for Test for Water Vapor Transmission of Thick Materials.
- I ASTM C449 Mineral Fiber Hydraulic Setting Thermal Insulation Cement.
- J ASTM C518 Heat Flux and Thermal Transmission Properties.
- K ASTM C533 Calcium Silicate Block and Pipe Thermal Insulation.
- L ASTM C534 Preformed Flexible Elastomeric Thermal Insulation.
- M ASTM C547 Mineral Fiber Preformed Pipe Insulation.
- N ASTM C552 Cellular Glass Block and Pipe Thermal Insulation.
- O ASTM C553 Mineral Fiber Blanket and Felt Insulation.
- P ASTM C578 Preformed, Block Type Cellular Polystyrene Thermal Insulation.
- Q ASTM C591 Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
- R ASTM C610 Expanded Perlite Block and Thermal Pipe Insulation.
- S ASTM C612 Mineral Fiber Block and Board Thermal Insulation.
- T ASTM C921 Properties of Jacketing Materials for Thermal Insulation.
- U ASTM C1136 Flexible Low Permeance Vapor Retarders for Thermal Insulation.
- V ASTM D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension.
- W ASTM D1000 Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications.
- X ASTM D1621 Standard Test Method for Compressive Properties Of Rigid Cellular Plastics.
- Y ASTM D1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics.
- Z ASTM D1940 Method of Test for Porosity of Rigid Cellular Plastics.
- AA ASTM D2126 Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
- BB ASTM D2240 Standard Test Method for Rubber Property—Durometer Hardness.
- CC ASTM E84 Surface Burning Characteristics of Building Materials.
- DD ASTM E814 Standard Test Method for Fire Tests of Penetration Firestop Systems.
- EE ASTM E2336 Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.
- FF MICA National Commercial & Industrial Insulation Standards.
- GG NFPA 225 Surface Burning Characteristics of Building Materials.
- HH UL 723 Surface Burning Characteristics of Building Materials.

1.05 QUALITY ASSURANCE

A Refer to Section 01 40 00 - Quality Requirements.

- B Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.
- C Insulation systems shall be applied by experienced Contractors. Within the past five (5) years, the Contractor shall be able to document the successful completion of a minimum of three (3) projects of at least 50% of the size and similar scope of the work specified in this section.

1.06 DESCRIPTION

- A Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:
 - 1. Pipe Insulation.
 - 2. Duct Insulation.
 - 3. Equipment Insulation.
- B Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these specifications, or where prior written approval has been obtained from the Owner Project Representative.

1.07 DEFINITIONS

- A Concealed: shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

1.08 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

1.09 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.10 ENVIRONMENTAL REQUIREMENTS

- A Do not store insulation materials on grade or where they are at risk of becoming wet. Do not install insulation products that have been exposed to water.
- B Protect installed insulation work with plastic sheeting to prevent water damage.

PART 2 PRODUCTS

2.01 MATERIALS

- A Manufacturers:
 - 1. Armacell: www.armacell.com.
 - 2. Certainteed: www.certainteed.com.
 - 3. Manson: www.imanson.com.
 - 4. Fibrex: www.fibrexinsulations.com.
 - 5. H.B. Fuller: www.hbfuller.com.
 - 6. Imcoa: www.nomaco.com.
 - 7. Johns Manville: www.johnsmanville.com.
 - 8. Knauf: www.knaufusa.com.
 - 9. Owens-Corning: www.insulation.owens-corning.com.
 - 10. Rubatex: www.rubatex.com.

11. VentureTape: www.venturetape.com.
 12. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Materials or accessories containing asbestos will not be accepted.
- C Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exceptions:
1. Pipe insulation which is not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 50 when tested in accordance with UL 723 and ASTM E84.

2.02 INSULATION TYPES

- A Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.
- Flexible Fiberglass Insulation:
1. Minimum nominal density of 0.75 lbs. per cu. ft., and thermal conductivity of not more than 0.3 at 75 degrees F, rated for service to 250 degrees F.
- B Rigid Fiberglass Insulation:
1. Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 degrees F.
 2. White paper encapsulated reinforced foil vapor barrier all service jacket, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.
- C Semi-Rigid Fiberglass Insulation:
1. Minimum nominal density of 3 lbs. per cu. ft., thermal conductivity of not more than 0.28 at 75 degrees F, minimum compressive strength of 125 PSF at 10% deformation, rated for service to 450 degrees F. Insulation fibers perpendicular to jacket and scored for wrapping cylindrical surfaces.
 2. White paper encapsulated reinforced foil vapor barrier all service jacket, factory applied to insulation with a maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.
- D Elastomeric Insulation:
1. Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.27 at 75 degrees F, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor permeability of 0.17 perm inch, maximum water absorption of 6% by weight, rated for service range of -20 degrees F to 220 degrees F on piping and 180 degrees F where adhered to equipment.
- E Polyolefin Insulation:
1. Flexible closed cell, minimum nominal density of 1.5 lbs. per cu. ft., thermal conductivity of not more than 0.24 at 75 degrees F, minimum compressive strength of 5 psi at 25% deformation, maximum water vapor permeability of 0.0 perm inch, maximum water absorption of 0% by weight and volume, rated for service range of -165 degrees F to 210 degrees F.

- F Extruded Polystyrene Insulation:
 - 1. Rigid closed cell, minimum nominal density of 1.6 lbs. per cu. ft., thermal conductivity of not more than 0.285 at 75 degrees F, minimum compressive strength of 20 psi, maximum water vapor permeability of 1.5 perm inch, maximum water absorption of .5 % by volume, rated for service range of -290 degrees F to 165 degrees F.
- G Mineral Wool Insulation:
 - 1. Rigid preformed mineral fiber, minimum nominal density of 8 lbs. per cu. ft., thermal conductivity of not more than 0.29 at 200 degrees F, minimum compressive strength of 3 psi, maximum wicking of 1%, maximum water adsorption of 1% by volume, rated for service of -120 degrees F to 1200 degrees F.
- H Pipe insulation shall be pre-formed in two (2) half cylinder sections. Cut V-groove sheet insulation is not acceptable. Provide three (3) stainless steel bands for each section of insulation.
- I Fireproofing Insulation:
 - 1. Mineral fiber with nominal density of 8 lbs. per cu. ft., flame spread index of 25, fuel contribution index of 0, and smoke developed index of 0, thermal conductivity of not more than 0.23 at 75 degrees F, rated for service of -120 degrees F to 1200 degrees F. Use rigid or semi-rigid board for duct insulations.
- J Foil-scrim-polyethylene vapor barrier jacket, factory applied to insulation, maximum permeance of .02 perms.
- K Fire-Stop Insulation:
 - 1. Noncombustible, non-asbestos, non-ceramic fiber, high temperature blanket or board fireproofing insulation, constructed of calcium silicate or calcium/magnesium/silica amorphous wool with 2-hour ASTM E814 "F" and "T" fire ratings, UL or equivalent third party listed, labeled and specifically evaluated for such purpose in accordance with ASTM E2336. Foil-scrim-polyethylene fiberglass reinforced factory applied jacket.

2.03 JACKETS

- A PVC FITTING COVERS AND JACKETS (PFJ):
 - 1. White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be minimum .02" indoors/.03" outdoors for piping 12 inches and smaller, .03" indoors/.04" outdoors for piping 15 inches and larger.
- B All Service Jackets (ASJ):
 - 1. Heavy duty, fire retardant material with white kraft reinforced foil vapor barrier, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.
- C Foil Scrim All Service Jackets (FSJ, also known as FRK or FSK):
 - 1. Glass fiber reinforced foil kraft laminate, factory applied to insulation. Maximum permeance of .02 perms and minimum beach puncture resistance of 25 units.
- D Protective Metal Jackets (PMJ):
 - 1. .016 inch thick aluminum or .010 inch thick stainless steel with safety edge.
- E Self-Adhering Jackets (SAJ):
 - 1. 5-ply, self-adhering multiple laminated waterproofing material with reflective aluminum foil, high density polymer films and cold weather acrylic adhesive providing zero (0.0) permeability.

2. Minimum 6 mils material thickness, 35lb puncture resistance when tested in accordance with ASTM D1000 and flame spread/smoke developed rating of 10/20 when tested in accordance with UL 723.
 3. Vapor retarding tape shall be specifically designed and manufactured for use with the self-adhering jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with self-adhering jackets shall have a maximum permeance of 0.0 perms.
- F Fabric Reinforced Mastic Jackets (FMJ):
1. Glass fiber reinforcing fabric imbedded in weather barrier mastic as per manufacturer's recommended procedure for 2 coat application.

2.04 INSULATION INSERTS AND PIPE SHIELDS

- A Manufacturers: B-Line, Pipe Shields, Value Engineered Products.
- B Construct inserts with calcium silicate or polyisocyanurate (service temperatures below 300 degrees F only), minimum 140 psi compressive strength. Piping 12 inches and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.
- C Where Contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to pre-engineered/pre-manufactured product described above. On low temperature systems, high density rigid polyisocyanurate may be substituted for calcium silicate provided insert and shield length and shield gauge are increased to compensate for lower insulation compressive strength.
- D Pre-compressed 18# density molded fiberglass blocks, ICA or equal, of the same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1"x6" block for piping through 2-1/2 inch and three 1" x 6" blocks for piping through 4 inch. Submit shield schedule to demonstrate equivalency to pre-engineered/pre-manufactured product described above.
- E Wood blocks will not be accepted.

2.05 EXPANSION JOINT AND VALVE INSULATION BLANKETS

- A Manufacturers: Advance Thermal Corporation, TANI Division B.D. Schiffler or approved equal.
- B Jacket shall be 7 ounce per square yard Teflon coated Nomex fabric which is designed for wet and dry steam applications to 550°F. Equal to Advance Thermal Corp. Steamguard-1 cloth. The covers shall be installed to shed water and have a 1-inch rain flap.
- C All seams shall be sewn twice with double locked stitching. One seam shall be sewn with 3-ply Nomex and the other with 3-ply stainless steel. Hog rings and staples shall not be used.
- D The insulation shall be a 2-inch thick, 6 lb. density ceramic fiber which is held in place with 12 gauge stainless quilt pins which do not puncture the inner surface of the cover.
- E Covers shall be designed to allow access to the expansion and ball joints packing cylinder plungers for repacking with removing the covers.
- F Adjacent pipe insulation must be installed to allow the piping to expand into expansion joints without damaging the insulation or removable covers.

2.06 ACCESSORIES

- A All products shall be compatible with surfaces and materials on which they are applied and be suitable for use at operating temperatures of the systems to which they are applied.

- B Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.
- C Insulation bands to be 3/4 inch wide, constructed of aluminum or stainless steel. Minimum thickness to be .015 inch for aluminum and .010 inch for stainless steel.
- D Tack fasteners to be stainless steel ring grooved shank tacks.
- E Staples to be clinch style.
- F Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.
- G Finishing cement to be ASTM C449.
- H Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.
- I Bedding compounds to be non-shrinking and permanently flexible.
- J Vapor barrier coatings to have maximum applied water vapor permeance of .05 perms.
- K Fungicidal water base coating (Foster 40-20 or equal) to be compatible with vapor barrier coating.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that all piping, equipment, and ductwork are tested and approved prior to installing insulation. Do not insulate systems until testing and inspection procedures are completed.
- B Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.

3.02 INSTALLATION

- A All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer's recommendations, building codes, and industry standards. Do not install products when the ambient temperature or conditions are not consistent with the manufacturer's recommendations. Surfaces to be insulated must be clean and dry.
- B Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.
- C Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Provide neatly beveled and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates.
- D Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.
- E Use full length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.
- F All pipe and duct insulation shall be continuous through walls, ceiling or floor openings and through sleeves except where firestop or firesafing materials are required. Vapor barriers shall be maintained continuous through all penetrations.
- G Provide a continuous unbroken moisture vapor barrier on insulation applied to systems noted below. Attachments to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- H Provide a complete vapor barrier for insulation on the following systems:
 - 1. Refrigerant.
 - 2. Insulated Duct.
 - 3. Equipment, ductwork or piping with a surface temperature below 65 degrees F.

3.03 PROTECTIVE JACKET INSTALLATION

- A Self-Adhering Jackets (SAJ):
 - 1. Install according to manufacturer's recommendations. Cut allowing minimum 4 inch overlap on ends and 6 inch on longitudinal joints. Align parallel to surface. Remove release paper and press flat to surface to avoid wrinkles. Rub entire surface for full adhesion and sealing at joint overlaps. On exterior applications, provide a bead of compatible caulk along exposed edges.

2. Piping with self-adhering (SAJ) jackets shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. Piping with a PVC jacket (PFJ) installed over the self-adhering (SAJ) jacket may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.
- B PVC Fitting Covers and Jackets (PFJ):
1. Lap seams and joints a minimum of 2 inches and continuously seal PVC with welding solvent recommended by jacket manufacturer. Lap slip joint ends 4 inches without fasteners where required to absorb expansion and contraction. For sections where vapor barrier is not required and jacket requires routine removal, tack fasteners may be used. Secure PVC fitting covers with tack fasteners. For systems requiring a vapor barrier, apply a 1-1/2 inch band of mastic over ends, throat, seams and penetrations.
- C Protective Metal Jacket (PMJ):
1. Lap seams a minimum of 2 inches. Secure with metal bands for end to end joints, and rivets or sheet metal screws for longitudinal joints. Rivets, screws, and bands to be constructed of the same material as the jacket. Locate seams on bottom for exterior applications.
- D Fabric Reinforced Mastic Jackets (FMJ):
1. Glass fiber fabric shall be fitted without wrinkles. Glass fiber fabric shall be sized immediately upon application with lagging adhesive and shall be capable of drying within 6 hrs. Apply adhesive and coating in accordance with manufacturer's recommendations. All seams shall overlap not less than 2 inches.

3.04 PIPING, VALVE, AND FITTING INSULATION

- A General:
1. Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2 inch lap on jacket seams and 2 inch tape on butt joints, firmly cemented with lap adhesive unless otherwise noted. Additionally secure with staples along seams and butt joints. Coat staples, longitudinal and transverse seams with vapor barrier mastic on systems requiring vapor barrier.
 2. Install insulation continuous through pipe hangers and supports with hangers and supports on the exterior of insulation. Where a vapor barrier is not required or where roller hangers are not being used, hangers and supports may be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration. Where riser clamps are required to be attached directly to piping requiring vapor barrier, extend insulation and vapor barrier jacketing/coating around riser clamp.
 3. Where insulated piping is installed on hangers and supports, the insulation shall be installed continuous through the hangers and supports. High density inserts shall be provided as required to prevent the weight of the piping from crushing the insulation. Pipe shields are required at all support locations. The insulation shall not be notched or cut to accommodate the supporting channels.
 4. Fully insulate all reheat coil piping, fittings and valves (with the exception of unions) up to coil connection to prevent condensation when coil is inactive during cooling season. Provide a vapor proof seal between the pipe insulation and the insulated coil casing.
- B Insulation Inserts and Pipe Shields:
1. Provide pipe shields at all hanger and support locations. Rigid insulation inserts shall be installed between the pipe and the insulation shields.

2. Quantity and placement of inserts shall be according to the manufacturer's installation instructions; however the inserts shall be no less than 12 inches in length. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required for system.
 3. Provide insulation inserts and pipe shields at all hanger and support locations. Inserts may be omitted on 3/4 inch and smaller copper piping provided 12 inch long 22 gauge pipe shields are used.
- C Fittings and Valves:
1. Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Where the ambient temperature exceeds 150 degrees F, cover insulation with fabric reinforcing and mastic. Where the ambient temperatures do not exceed 150 degrees, furnish and install PVC fitting covers.
- D Mineral Fiber:
1. Secure each 3 foot section with three stainless steel bands or five 16 gauge stainless steel or annealed copper tie wires evenly spaced and at ends. Twist wire ends, snip off excess and turn ends over into insulation. Stagger joints where more than one layer is used.
- E Closed Cell Elastomeric Thermal Insulation:
1. Flexible closed cell, thermal conductivity 0.245, water vapor transmission of 0.03 perm inch, UV resistance minimal change ASTM G 7 and ASTM G 90, fire rating will not contribute significantly to fire (simulated end-use testing), recommended service temperature range is -297 degrees F to 257 degrees, designed for installation above and below ground.
 2. Flame spread rating of 25 or less and a smoke developed rating of 50 or less as tested by ASTM E 84 "Surface Burning Characteristics of Building Materials".
 3. Two step sealing system to insure a permanent seal. Step 1 an acrylic adhesive seam seal on the inside of the longitudinal joint. Step 2 EPDM flap that utilizes a cellular fusion adhesive that closes across the top of the longitudinal seam. This adhesive chemistry bonds the EPDM to the tube ensuring a seal for the life of the system. Butt joints and other seams are to be sealed with contact adhesive. Fittings can be fabricated from straight tubing or sheet. Larger diameter, curved, or flat surfaces can be insulated by adhering properly fabricated sheet sections to them.
- F Elastomeric and Polyolefin:
1. Where practical, slip insulation on piping during pipe installation when pipe ends are open. Miter cut fittings allowing sufficient length to prevent stretching. Completely seal seams and joints for vapor tight installation. For elastomeric insulation, apply full bed of adhesive to both surfaces. For polyolefin, seal factory pre-glued seams with roller and field seams and joints with full bed of hot melt polyolefin glue to both surfaces. Cover elastomeric insulation on systems operating below 40 degrees F with vapor barrier mastic.
- G Extruded Polystyrene and Polyisocyanurate:
1. Fittings, valves, unions, flanges, couplings and specialties shall be insulated with factory molded insulation of the same thickness as adjoining insulation. Secure insulation sections with two wraps of nylon filament tape 9"-12" on center. On single insulation layer systems and on the outer layer of double insulation layer systems, apply a thin coat of elastomeric joint sealant rated for system operating temperatures to all longitudinal and butt insulation joints covering entire face of joint. Allow sealant to fully cure before applying protective covering. For piping service below 0oF, use two layers of insulation with inner and outer butt and longitudinal joints staggered and offset 90 degrees. Where two layers of insulation are used, do not use sealant on the inner layer or adhere the inner layer to the outer layer.

2. Apply vapor stop bead of joint sealant between pipe and insulation on both sides of valves, expansion/contraction joints, flanges, thermometers/gauges, attached vent and drain lines. Insulate attached non-circulated lines, control lines, vents, etc. for a minimum distance of 6 inches from pipe. Cover insulation with a protective jacket as specified below. Do not penetrate protective covering or insulation with mechanical fasteners.

3.05 PIPING PROTECTIVE JACKETS

- A In addition to the jackets specified in the pipe insulation schedule below, the following protective jackets are required:
1. Provide a protective PVC (PFJ) or Fabric Reinforced Mastic (FMJ) jacket for the following insulated piping:
 - a. All piping within mechanical rooms.
 - b. All piping within 8 feet of the mechanical room floor, or in areas determined to be susceptible to damage.
 2. Provide a protective metal (PMJ) or self-adhering (SAJ) jacket for the following insulated piping:
 - a. Exterior installed refrigeration piping.
 3. Provide a protective metal jacket (PMJ) for the following insulated piping:
 - a. Piping exterior to the building.
 - b. All piping within 8 feet of the mechanical room floor, or in areas determined to be susceptible to damage.

3.06 PIPE INSULATION SCHEDULE

- A Provide insulation on new and existing remodeled piping as indicated in the following schedule:

Service	Insulation	Jacket	Insulation Thickness By Pipe Size				
			≤ 1-1/4"	1-1/2"	2" to < 4"	4" to 6"	8" and Larger
Heating Hot Water	Rigid Fiberglass	ASJ	1.5"	1.5"	2"	2"	2"
Note: On 1" or smaller hot water pipe runouts to terminal unit coils the insulation thickness may be reduced to 1/2" on both the supply and return pipes within 4ft of the coil but not on the distribution system side of the temperature control valve.							
Cooling Coil	Rigid Fiberglass	ASJ	0.5"	0.5"	1"	1"	1"
Cooling Coil Condensate Drain Piping	Rigid Fiberglass	ASJ	0.5"	0.5"	1"	1"	1"
Refrigerant Suction:							
>40°F	Elast./Polyol	None	0.5"	1"	1.5"	1.5"	1.5"
40°F to 20°F	Elast./Polyol	None	1"	1.5"	1.5"	1.5"	1.5"
20°F to -20°F	Ext Poly/Polyiso	VRJ or SAJ	1.5"	2"	2"	2"	2.5"
-20°F to -60°F	Ext Poly/Polyiso	VRJ or SAJ	2"	2"	2.5"	2.5"	3"

- B The following piping and fittings are not to be insulated:
1. Hot water piping inside radiation, convector, or cabinet heater enclosures.

2. Piping unions for systems not requiring a vapor barrier.
- C For systems with fluid temperatures 65° F or less, furnish and install removable elastomeric insulation covers, plugs or caps for all mechanical equipment and devices that require access by balancing Contractors or service and maintenance personnel. Examples include but are not limited to: flow sensing devices, circuit setters, manual ball valve air vents, drain valves, blowdown valves, pressure/temperature test plugs, grease fittings, pump bearing caps, equipment labels, etc. Covers shall be tight fitting to ensure a complete vapor barrier.

3.07 DUCT INSULATION

- A General:
1. Secure flexible duct insulation on sides and bottom of ductwork over 24 inch wide and all rigid duct insulation with weld pins. Space fasteners 18 inch on center or less as required to prevent sagging.
 2. Secure rigid board insulation to ductwork with weld pins. Apply insulation with joints firmly butted as close as possible to the equipment surface. Pins shall be located a maximum of 3 inches from each edge and spaced no greater than 12 inch on center.
 3. Install weld pins without damage to the interior galvanized surface of the duct. Clip pins back to washer and cover penetrations with tape of same material as jacket. Firmly butt seams and joints and cover with 4 inch tape of same material as jacket. Seal tape with plastic applicator and secure with staples. All joints, seams, edges and penetrations to be fully vapor sealed.
 4. Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation or jacket material.
 5. External supply duct insulation is not required where ductwork contains continuous 1 inch acoustical liner. Provide 4 inch overlap of external insulation over ends of acoustically lined sections.
 6. Where insulated ductwork is supported by trapeze hangers, the insulation shall be installed continuous through the hangers. Drop the supporting channels required to facilitate the installation of the insulation. Where rigid board or flexible insulation is specified, install high density inserts to prevent the weight of the ductwork from crushing the insulation.
 7. Where insulated low temperature (below 45°F) ductwork is supported by steel metal straps or wire ropes that are secured directly to the duct, the straps or ropes shall be completely covered with insulation and sealed to provide a complete vapor barrier.
 8. Where insulated duct risers are supported by steel channels secured directly to the duct, extend the insulation and vapor barrier jacketing to encapsulate the support channels.

3.08 DUCTWORK PROTECTIVE COVERINGS

- A In addition to the jackets specified in the duct insulation schedule below the following protective coverings are required:
- B Provide a protective covering of 2 coats of indoor/outdoor vapor barrier mastic with fibrous glass or canvas fabric covering (FMJ) for the following ductwork:
1. Ductwork within 6' of floor, catwalks and mezzanines in mechanical rooms.

3.09 DUCT INSULATION SCHEDULE

A Provide duct insulation on new and existing remodeled ductwork in the following schedule:

Service	Insulation Type	Jacket	Insulation Thickness
Outside air ducts	Rigid Fiberglass	FSJ	3"
Mixed air ducts	Rigid Fiberglass	FSJ	3"
Exposed supply ducts*	Rigid Fiberglass	FSJ	2"
Concealed supply ducts	Flexible Fiberglass	FSJ	1-1/2"
All Ducts located in unconditioned Attics***	Flexible Fiberglass	FSJ	3"
Exhaust & relief ducts downstream of motorized back-draft dampers	Rigid Fiberglass	FSJ	2"

* Exposed supply branch ducts located in the space they are serving do not require insulation. Exposed supply main ducts running through spaces they serve shall be insulated as exposed supply ducts scheduled above.

3.10 EQUIPMENT INSULATION

A General:

- Do not insulate over equipment access manholes, fittings, nameplates or ASME stamps. Bevel and seal insulation at these locations.

B Protective Jackets:

- Provide a protective metal jacket (PMJ) for the following: Generator exhaust pipe (that is not concealed in a shaft) and muffler.

C Semi-Rigid Fiberglass:

- Apply insulation to equipment shells using weld pins, bonding adhesive, banded and wired in place. Fill all joints, seams and depressions with insulating cement to a smooth, even surface. Cover with reinforcing fabric and 2 coats of mastic (FMJ). Use vapor barrier mastic on systems requiring a vapor barrier.

D Elastomeric/Polyolefin:

- Apply full cover coat of adhesive to surface to be insulated, insulation and edge butt joints. Place insulation with edge joints firmly butted pressing to surface for full adhesion. Seal seams and joints vapor tight.

3.11 EQUIPMENT INSULATION SCHEDULE

A Provide equipment insulation as follows:

Equipment	Insulation	Jacket	Thickness Type
Reheat coil casing in exposed supply ducts	Rigid Fiberglass	FSJ	2"
Reheat coil casing in concealed supply ducts	Flexible Fiberglass	FSJ	1-1/2"
Hot Water Air separators	Semi-Rigid Fiberglass	ASJ/FMJ	1.5"
Air Handling Unit Casings or attached component sections not factory insulated*	Rigid Fiberglass	ASJ	2"

- * The thickness and type of insulation provided for non-factory fabricated transitions or component sections shall be consistent with the sections constructed at the factory.

3.12 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

END OF SECTION 23 07 00

INTENTIONALLY LEFT BLANK

SECTION 23 09 13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 PROJECT SPECIFIC COORDINATION REQUIREMENTS

- A Combination fire/smoke and smoke dampers: Installation, wiring not shown on electrical plans, wiring of end switches.

1.02 SCOPE

- A This section includes the end devices required for stand-alone control and / or the components required for a fully functional DDC control system specified in Section 23 09 23. Included in this section are the following topics:

1. PART 1 – GENERAL.
 - a. Project Specific Coordination Requirements.
 - b. Scope.
 - c. Related Work.
 - d. Reference.
 - e. Work Not Included.
 - f. Quality Assurance.
 - g. Reference Standards.
 - h. Submittals.
 - i. Demolition.
 - j. Design Criteria.
 - k. Operation and Maintenance Data.
 - l. Warranty.
 - m. Material Delivery and Storage.
2. PART 2 – PRODUCTS.
 - a. Control Dampers.
 - b. Smoke and Combination Fire / Smoke Dampers.
 - c. Duct Smoke Detector and Fire Alarm Interface Modules.
 - d. Control Valves.
 - e. Control System Instrumentation.
 - f. Electric/Electronic Thermostats.
 - g. Temperature Control Panels.
 - h. Air Flow Stations.
 - i. Temperature Sensors.
 - j. Humidity Sensors.
 - k. Air Pressure Transducers.
 - l. Liquid / Steam Pressure Transducers.
 - m. Air Differential Pressure Switches.
 - n. Liquid Differential Pressure Switches.
 - o. Current Status Switches.
 - p. Carbon Dioxide (CO₂) Sensor.
 - q. Power Supplies.

3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Control, Combination Fire/Smoke, and Smoke Dampers.
 - c. Control Valves.
 - d. Control System Instrumentation.
 - e. Electric/Electronic Room Thermostats.
 - f. Temperature Control Panels.
 - g. Low Limit Thermostats.
 - h. Air Flow Stations.
 - i. Room Sensors.
 - j. Air and Water Pressure Transducers.
 - k. Air and Liquid Differential Pressure Switches.
 - l. Water Flow Switches.
 - m. Current Status Switches.
 - n. Carbon Dioxide Sensors.
 - o. Construction Verification Items.
 - p. Owner Training.

1.03 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
- B Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC – Coordination.
- C Input / Output Summary - See project drawings.
- D Section 23 09 23 - Direct Digital Control System for HVAC - Competitive Bid.
- E Section 23 09 93 - Sequence of Operation.
- F Section 23 33 00 - Ductwork Accessories - for control damper installation.
- G Division 23 - HVAC - Equipment provided to be controlled or monitored.
- H Division 26 - Electrical - Installation requirements & Equipment provided to be controlled or monitored.
- I Division 28 - Electronic Safety and Security.

1.04 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.05 WORK NOT INCLUDED

- A Direct digital controls and energy management interface, as specified in Section 23 09 23.

1.06 QUALITY ASSURANCE

- A Installing Contractor must be a manufacturer's branch office or an authorized representative of the control equipment manufacturer that provides engineering and commissioning of the manufacturers control equipment, submit written confirmation of such authorization from the manufacturer. Indicate in letter of authorization that installing Contractor has successfully completed all necessary training required for engineering, installation, and commissioning of equipment and systems to be provided for the project, and that such authorization has been in effect for a period of not less than three years.

1.07 REFERENCE STANDARDS

- A ANSI B16.22 - Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
- B ANSI/ASTM B32 - Specification for Solder Metal.
- C ASTM B75 - Seamless Copper Tube.
- D ASTM D1693 - Environmental Stress-Cracking of Ethylene Plastics.

- E ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
- F UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
- G AMCA 500-D - Laboratory Method of Testing Dampers for Rating.

1.08 SUBMITTALS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Include the following information:
 1. Manufacturer's data sheets indicating model number, pressure/temperature ratings, capacity, methods and materials of construction, installation instructions, and recommended maintenance. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked.
 2. Schematic flow diagrams of systems showing fans, pumps, coils, dampers, valves, and other control devices. Label each device with setting or adjustable range of control. Indicate all wiring, clearly, differentiating between factory and field installed wiring. Wiring should be shown in schematics that detail contact states, relay references, etc. Diagrammatic representations of devices alone are not acceptable.
 3. Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Also include on drawings location of mechanical equipment controlled (room number), horsepower and flow of motorized equipment (when this data is available on plans), locations of all remote sensors and control devices (either by room number or column lines).
 4. Schedule of control dampers indicating size, leakage rating, arrangement, pressure drop at design airflow, and number and size of operators required.
 5. Schedule of control valves indicating system in which the device is to be used, rated capacity, flow coefficient, flow required by device served, actual pressure drop at design flow, size of operator required, close-off pressure, and locations where valves are to be installed.
 6. A complete description of each control sequence for equipment that is not controlled by direct digital controls. Direct digital controlled equipment control sequences will be provided by the DDC Control Contractor.
 7. Calculations completed to determine size of control air compressor(s) and dryer (s).
 8. Prior to request for final payment, submit record documents which accurately record actual location of control components including panels, thermostats, wiring, and sensors. Incorporate changes required during installation and start-up.

1.09 DEMOLITION

- A Where existing control devices, piping, or wiring are discontinued from use, remove and turn over to Owner. If Owner does not want them, remove from premises. Remove any previously abandoned control devices in a similar manner.
- B Electric controls must be removed to their power source.
- C Electronic controls must be removed, and all associated wiring no longer required. Remove any junction boxes, control panels, and conduit that are to be abandoned.
- D Pneumatic controls shall be completely removed. Any tubing and conduit associated with the pneumatic controls shall be removed to the closest in use junction box or control panel. Plug and tag all abandoned air mains.

- E Provide blank cover plates for all removed room thermostats or sensors. Plug and seal all abandoned duct penetrations.

1.10 DESIGN CRITERIA

- A Size all control apparatus to properly supply and/or operate and control the apparatus served.
- B When devices are identical the product shall be from one manufacturer.
- C Provide control devices subject to corrosive environments with corrosion protection or construct them so they are suitable for use in such an environment.
- D Provide devices exposed to outside ambient conditions with weather protection or construct them so they are suitable for outdoor installation.
- E Provide all required components not specifically indicated or specified but necessary for a completely functioning system.
- F Use only UL labeled products that comply with NEMA Standards. Electrical components and installation to meet all requirements of the electrical sections (Division 26) of project specifications.

1.11 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 Closeout Submittals.

1.12 WARRANTY

- A Provide a 1 year warranty on all materials and workmanship.

1.13 MATERIAL DELIVERY AND STORAGE

- A Provide factory shipping cartons for each piece of equipment and control device. This Contractor is responsible for storage of equipment and materials inside and protected from the weather.

PART 2 PRODUCTS

2.01 CONTROL DAMPERS

- A Provide control dampers shown on the plans and as required to perform the specified functions. Dampers shall be rated for velocities that will be encountered at maximum system design and rated for pressure equal or greater than the ductwork pressure class as specified in Section 23 31 00 of the ductwork where the damper is installed.
- B Use only factory fabricated dampers with mechanically captured replaceable resilient blade seals, stainless steel jamb seals and with entire assembly suitable for the maximum temperature and air velocities encountered in the system.
- C All dampers in stainless steel, PCD coated steel, PVC, PTFE, or fiberglass ductwork shall be constructed of stainless steel.
- D All dampers in aluminum ductwork shall be constructed of stainless steel or aluminum.
- E Dampers in galvanized ductwork shall be constructed of galvanized steel and/or aluminum.
- F All dampers, unless otherwise specified, to be rated at a minimum of 180 °F working temperature. Leakage testing shall be certified to be based on latest edition of AMCA Standard 500-D and all dampers, unless otherwise specified, shall have leakage ratings as follows:

Damper Class	Differential Pressure	Leakage
Class IA	1" w.g.	≤3 CFM/ft ²
Class I	4" w.g.	≤8 CFM/ft ²
Class I	8" w.g.	≤11 CFM/ft ²
Class I	12" w.g.	≤14 CFM/ft ²

- G Leakage rate dampers for differential pressures that they will encounter at maximum system design pressures.
- H Steel framed dampers: Nailor models 2010 & 2020; Greenheck models VCD-33 & VCD-42; Johnson Controls model V-1330; Ruskin Models CD60 & CD40; other approved equal.
- I Aluminum frame and blade dampers: Nailor models 2010EAF & 202EAF; Greenheck model VCD-43; Ruskin model CD50; Arrow model AFD-20; other approved equal.
- J Dampers used for directed mixing of airstreams, i.e. outside air and return air, to be parallel blade type and sized for an air velocity of 1800 to 2000 fpm with the damper blades shall be arranged so that the air streams are directed at one another to facilitate mixing. Dampers used for throttling or modulating applications other than air stream mixing to be opposed blade type. Two position dampers may be parallel or opposed blade type.
- K Dampers used for isolation on the discharge of centrifugal fans shall have damper blades perpendicular to the fan shaft to minimize system effect. Dampers mounted with blades vertically shall be designed for vertical blade orientation.
- L Dampers for applications other than fume exhaust to have frames of not less than 16 gauge galvanized steel or 12 gauge extruded aluminum. Blades to be two-ply steel airfoil of not less than 2 x 20 gauge galvanized steel (14 gauge equivalent) or extruded aluminum airfoil, with stainless steel, acetal, Celcon, bronze, or nylon bearings. Maximum allowable blade width is 8 inches. Use plated steel linkage hardware.
- M Insulated low leak dampers shall have frames 8-1/8 inches X 1 inch X minimum 0.081 inch 6063-T-5 extruded aluminum hat-shaped channel, mounting flanges on both sides of frame and reinforced at the corners. Thermal gaskets break to prevent heat transmission through the frame. Minimum 2 insulated blade sets with a minimum of 4 inches of dead air space between sets. Dampers shall be Ruskin CD40X2 or equal.
- N Maximum damper width is 48 inches; where required width exceeds 48 inches, use multiple damper sections. Inside frame free area shall be a minimum of 90% of total inside duct area.
- O Multiple width damper sections shall utilize jack shaft linkages unless noted below. Sections over 144 inches wide shall be actuated from two locations on the jack shaft. Double width damper sections for two-position operation may be actuated without jack shafts if each damper section is actuated separately. Dampers that have multiple width and multiple vertical sections shall have a jackshaft for each vertically stacked set of dampers and be provided with crossover linkages between jack shafts to transfer uneven loading.
- P Jack shafts shall be extended outside of the ductwork for external actuator mounting. Provide bearings on the point of exit for support of damper shafts to prevent wear on the shaft and the ductwork. If locating actuators out of the air stream is impossible, obtain mounting location approval from the designer unless the contract documents indicate in air stream mounting is acceptable. In no cases shall damper actuators for fume exhaust systems be located in the air stream or require entering the air stream to service an actuator.
- Q Provide weatherproof stainless steel enclosures that have removable covers that do not require removing fasteners from the ductwork or NEMA 4 watertight actuators (Elodrive or equal) to prevent actuator failure or freeze-up when mounting in locations exposed to harsh environments or outdoor locations.
- R Size operators for smooth and positive operation of devices served, and with sufficient torque capacity to provide tight shutoff against system temperatures and pressure encountered.

- S For electric modulating actuation, use fully proportional actuators with 0-10VDC inputs and zero and span adjustments. For two-position electric actuation use 24 VAC for DDC controlled actuators, 120 VAC actuators may be used for hardwire interlocking. Actuator stroke times shall match the requirements of the DDC controllers provided under section 23 09 23 and/or the specific system requirements for proper operation as specified in section 23 09 93. All electric actuators will be provided with overload protection to prevent motor from damage when stall condition is encountered. Equip operators with spring return or stored energy fail-safe return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. Provide damper end switches with form "C" contacts where control sequences require damper position indication. End switches shall not contain mercury.
- T All power required for electric actuation shall be provided by this Contractor if it is not able to be directly provided from the DDC controller.
- U Provide operators with linkages and brackets for mounting on device served.

2.02 SMOKE AND COMBINATION FIRE / SMOKE DAMPERS

- A Manufacturers:
 1. Ruskin: www.ruskin.com.
 2. Johnson Controls: www.johnsoncontrols.com.
 3. Air Balance: www.airbalance.com.
 4. Advanced Air: www.advancedair.net.
 5. American Warming and Ventilating: www.awv.com.
 6. Greenheck: www.greenheck.com.
 7. Safe-Air: www.safe-air-corp.com.
 8. Phillips-Aire: www.drillspot.com.
 9. Prefco: www.prefco-hvac.com.
 10. Pottorff: www.pottorff.com.
 11. United Enertech: www.unitedenertech.com.
 12. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Smoke damper assemblies to be UL 555S (4th edition) listed and labeled, and leakage rated at no higher than Class II under UL 555S (4th edition). Unless ratings are indicated elsewhere, dampers should be rated for minimum 2,000 fpm air velocity and 4" static pressure.
- C Combination fire/smoke damper assemblies to be UL 555(6th edition) and UL 555S(4th edition) listed and labeled and have a fire rating compatible with the rating of the building assembly in which the damper is used, and be leakage rated at no higher than Class II under UL 555S.
- D Provide factory installed electrically operated dampers with linkage arranged so that the damper is closed on loss of power. For electric actuation, provide electric operated dampers with linkage and UL listed operators arranged so that the damper is closed on a loss of power. Where electric actuation is controlled by the DDC system use 0-10 VDC inputs, with stall protection, and with zero and span adjustments for modulating or 24 VAC for two-position control. All electric actuators will be provided with overload protection to prevent motor from damage when stall condition is encountered. Locate all operators out of the air stream unless large damper size will not allow. Provide form "C" end switches to indicate damper position.
- E Use airfoil shaped damper blades equal to Ruskin FSD60 when duct velocity will exceed 2,000 fpm.

2.03 DUCT SMOKE DETECTOR AND FIRE ALARM INTERFACE MODULES

- A Detectors with auxiliary contacts or fire alarm control modules will be provided by others. Provide wiring, conduit, and necessary interface with fire alarm system to perform specified sequence of operation.

2.04 CONTROL VALVES

- A Provide all control valves as shown on the plans/details and as required to perform functions specified.
- B Size operators to allow smooth and positive operation of devices served and to provide sufficient torque capacity for tight shutoff against system temperatures and pressure encountered. For electric modulating actuation, use fully proportional actuators with 0-10VDC inputs and zero and span adjustments unless specified otherwise in the chart below. If Floating with feedback is specified, valve position shall be fed back to the controller and controller shall position valve based on this feedback. For two-position electric actuation use 24 VAC for DDC controlled actuators, 120 VAC actuators may be used for hardwire interlocking. Electric actuators, for applications other than terminal units, shall be provided with a manual override capability. All electric actuators shall be provided with a visible position indicator.
- C All power required for electric actuation shall be provided by this Contractor if it is not able to be directly provided from the DDC controller.
- D Provide operators that are full proportioning or two-position, as required for specified sequence of operation. Provide spring-return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. Valves shall move to their fail positions on loss of electrical power or air pressure to the actuator.
- E Two-position shut-off valves shall be sized for a maximum pressure drop of 2 PSI at design flow and shall be a minimum of line size.
- F Provide operators with linkages and brackets for mounting on device served.
- G All valves unless specifically noted on the plans or indicated below shall be globe style valves.

CONTROL VALVE APPLICATION	TYPE	SIGNAL	SPRING RETURN REQUIRED	FAIL POSITION
	Globe Butterfly (BF) Ball Press Independent Ball (PI Ball)	0-10 VDC Floating (24VAC) 2-Position Elect		Open (thru Coil) Closed (bypass Coil) In Place
VAV Reheat	Globe or Ball	0-10 VDC or Floating with feedback	No	In Place
Radiation with Reheat	Globe or Ball	Floating	No	In Place
Stand-alone Radiation	Globe or Ball	0-10 VDC	No	In Place
CUH and UH	Globe or Ball	Floating or 2-Pos Elect	Yes	Open
AHU Heating Coil	Globe	0-10 VDC	Yes	Open
AHU Cooling Coil	Globe or BF ¹	0-10 VDC	Yes	Closed

See plan details, notes, and schedules for where two-way and three-way valves should be used.

Equivalent Cv butterfly valves may be used where 3 inch and larger globe valves would be required.

H WATER SYSTEMS:

1. Use equal percentage valves for two-way control valves; size for a pressure drop not less than 4 psi or more than 6 psi.

2. Use three-way valves sized for a maximum pressure drop of 5 psi and that have linear characteristics so that the valve pressure drop remains constant regardless of the valve position.
3. Globe valves 2 inches and smaller: Cast bronze or forged brass body, brass plug and brass or stainless steel seat, stainless steel stem, screwed ends, suitable for use on water systems at 150 psig and 240 °F. Seat leakage with actuator supplied will meet ANSI class IV leakage (0.01%). Only the following globe valve body styles will be acceptable for terminal unit control: Siemens Powermite 599 VF Series (599 VE Series Zone Valves are not acceptable), Invensys VB7200 Series, Johnson Controls VG7000 Series, and Honeywell V5011/V5013 Series or approved equal. Minimum size for globe valves shall be 1.5 Cv.
4. Globe valves 2-1/2 inches and larger: Iron body, brass plug and seat, stainless steel stem, spring loaded Teflon, or EPDM packing, flanged ends, suitable for use on water systems at 150 psig and 240 °F.
5. Butterfly valves: Iron body, stainless steel shaft, bronze bearings, and resilient seat. Disc to be aluminum-bronze, nickel-plated ductile iron, cast iron with welded nickel edge, or stainless steel. Valve assembly to be bubble tight, suitable for use on water systems at 150 psig and 240 °F. For pneumatically actuated valves, provide pilot positioners on all operators for butterfly valves used in modulating applications. When butterfly valves are used in modulating applications, entering and leaving pipe sizes and required transition distances shall be detailed on the control valve submittals. The Control Contractor shall be responsible for coordinating the proper pipe sizes and transitions with the Mechanical Contractor to provide the correct Cv at 70° open position.
6. Characterized Ball Valves: The following manufacturers are acceptable: Honeywell, Belimo, Johnson Controls, KMC Controls, Yamatake. For use on terminal units only where specified above. Forged brass or bronze body, stainless steel shaft and ball, reinforced Teflon or PTFE ball seals, double O-ring stem seals, characterized disk, maximum of ANSI Class IV (0.01%) leakage, suitable for use on water systems at 150 psig and 212 °F. Minimum size for ball valves shall be 1.0 Cv.

2.05 CONTROL SYSTEM INSTRUMENTATION

A DUCT THERMOMETERS:

1. 3-1/2 inch dial type with swivel mount. Maximum scale graduations of 2 °F. Provide averaging type, liquid filled capillary sensing element.

B PIPE THERMOMETERS:

1. 9 inch stem type with an adjustable swivel mount. Scale graduations of 2 °F and mid-range accuracy of ±1 °F. Install thermometers in separable brass wells filled with conductive fluid.

C REMOTE BULB THERMOMETERS:

1. 3-1/2 inch dial type with recalibration screw on face. Accuracy within 1% of scale range. Thermometers with sensing elements in air ducts with an area of above 4 square feet to have averaging elements. Provide separable wells for all pipeline applications.

2.06 ELECTRIC/ELECTRONIC THERMOSTATS

A ELECTRIC THERMOSTATS: (On/Off or two-position control)

1. For single setpoint applications 55 °F to 85 °F, provide line or low voltage electric type suitable for heating or heating and cooling as required. Provide the required number of heating and/or cooling stages required for the application. For line voltage ventilation applications utilizing fans and where otherwise specified in the sequence of operations, provide an integral manual On/Off/Auto selector switch. Minimum contact rating shall be equal to electrical load of device being controlled. Provide on UL listed devices rated for the application.

- B LOW VOLTAGE ELECTRONIC THERMOSTATS: (Stand-alone modulating control)
 - 1. Manufacturers:
 - a. Honeywell: www.honeywell.com.
 - b. Johnson Controls: www.johnsoncontrols.com.
 - c. White Rogers: www.whiterogers.com.
 - d. Siemens: www.siemens.com.
 - e. Substitutions: Refer to Section 01 60 00 - Product Requirements.
 - 2. Where unoccupied setpoints are specified, provide electronic programmable type with seven day setup/setback scheduling with a minimum of two occupied and unoccupied schedules per day through keypad entry on front of unit. For heating and cooling applications, provide automatic heating/cooling switchover. For applications that control fans, provide fan override switch. For ventilation or packaged economizer applications provide a dry contact for ventilation damper or economizer initiation. For thermostat control of economizer, provide a 0-10VDC modulated output for economizer damper control.
 - 3. For applications that require integration to the building automation system, provide a BACnet communication interface.
- C AQUASTATS:
 - 1. Line voltage type with single pole, double throw switch of adequate rating for the applied load.
- D REMOTE BULB THERMOSTATS:
 - 1. Line voltage type with single pole, double throw switch of adequate rating for the applied load. Thermostat to have adjustable setpoint suitable for controlled load.
- E LOW LIMIT THERMOSTATS (freezestats):
 - 1. Electric two-position type with temperature sensing element and manual reset. Unit to be capable of opening control circuit if any one-foot length of sensing element is subject to a temperature below the setpoint. Length of sensing element to be not less than one lineal foot per square foot of coil surface areas. Unless otherwise indicated, set low limit controls at 36 °F.

2.07 TEMPERATURE CONTROL PANELS

- A Constructed of steel or extruded aluminum, with hinged door, keyed lock, and baked enamel finish. Install controls, relays, transducers and automatic switches inside panels. Label devices with permanent printed labels and provide as-built wiring/piping diagram within enclosure. Provide raceways for wiring and poly within panel for neat appearance and to separate high and low voltage wiring. Provide termination blocks and resettable circuit breaker for 120VAC power wiring. Label panel with panel number corresponding to as-built control drawings and building system(s) served.

2.08 AIR FLOW STATIONS

- A Provide duct mounted airflow station type based on the following minimum design velocities. Pitot or thermal dispersion flow stations can be used for fan inlet flow stations. Outside air flow stations shall be thermal dispersion type only. Turndown of variable volume fan systems must be considered. Provide an airflow station schedule detailing the airflow range to be measured, corresponding velocity pressure, differential pressure transducer range, and the airflow station size.

<u>Air Velocity</u>	<u>Duct Mounted Air Flow Station Type</u>
0-700 FPM	Thermal Dispersion
>700 FPM	Thermal Dispersion or Multi-probe velocity pressure pitot style

- B Duct mounted Multi-probe velocity pressure pitot air flow stations:

1. Multi-probe duct velocity pressure sensing station constructed of minimum 16 gauge galvanized steel casing, and multiple metallic velocity pressure sensors with automatic averaging manifold. For duct installations, provide an aluminum honeycomb cell air straightener with maximum openings of 1/2 inch and minimum of 3 inch depth. Each airflow measuring element shall contain multiple Total and Static pressure sensors, placed at equal distances (for rectangular Ducts) and at concentric area centers (for circular ducts) along the element length. The number of sensors on each element and the quantity of elements utilized at each installation shall comply with the ASHRAE standards for duct traversing. The airflow measuring elements shall be capable of producing steady, non-pulsating Total and Static pressure signals, with accuracy within $\pm 2\%$ of actual flow. Airflow resistance to be less than or equal to 0.23 inches of water at 4000 feet per minute air velocity.
- C Fan inlet probe air flow stations:
1. For fan inlet probes provide two probes for each fan inlet (for DWDI fans provide four probes). Pressure drop caused by the airflow elements shall not exceed 0.03" w.c. at 2000 FPM. Airflow elements shall be provided with all necessary pivot mounting hardware and signal connection fittings for connection to tubing provided by the installing Contractor. For pitot type air flow stations, the static and total pressure manifold piping by the installing Contractor shall be piped symmetrically so take-off will be located where line lengths between all probes are equal in length.
- D For duct mounted and fan inlet pitot flow stations, air velocity transducers range shall be sized less than two times the design velocity pressure at maximum flow and will meet the requirements under the PRESSURE TRANSDUCERS (AIR) specification later in this specification section unless noted below.
- E Thermal dispersion air flow stations:
1. Manufacturers:
 - a. Ebtron, Air Monitor, Kurz Instruments.
 - b. Probe Sensor Density:

<u>Area (sq. ft.)</u>	<u>Sensors</u>
<= 1.5	2
>1.5 to <4	4
4 to <8	6
8 to <12	8
12 to <16	12
>=16	15
 - c. Airflow Sensor Accuracy: $\pm 2\%$ of reading.
 - d. Calibrated Range: 0-5000 FPM.
 - e. Temperature Sensor Accuracy: $\pm 0.15^\circ\text{F}$.
 - f. Temperature: -20°F to $+140^\circ\text{F}$.
 - g. Relative Humidity: 0 to 95% (non-condensing).
- F Provide transmitter that will average up to sixteen sensors and provide two field selectable linear analog output signals (4-20mA and 0-10 VDC) proportional to airflow and temperature. Sensor electronic circuitry other than the temperature sensors shall not be exposed to the air stream and shall be protected from moisture to prevent failure.
- G Local display of flow rate to be provided in a steel NEMA 4 wall mounted enclosure with internal terminal strip connections and shall be powered by 24 VAC or VDC and provide necessary power to flow meter. Display shall read in cubic feet per minute.

2.09 TEMPERATURE SENSORS

- A Use thermistor or RTD type temperature sensing elements constructed so accuracy and life expectancy is not affected by moisture, physical vibration, or other conditions that exist in each application.
- B RTD's shall be of nickel or platinum construction and have a base resistance of 1000Ω at 70°F and 77°F respectively. 100Ω platinum RTD's are acceptable if used with temperature transmitters.
- C The temperature sensing device used must be compatible with the DDC controllers used on the project.
- D RTD:
 - 1. Accuracy (Room Sensor Only) minimum $\pm 1.0^\circ\text{F}$.
 - 2. Accuracy (Averaging) minimum $\pm 1.2^\circ\text{F}$.
 - 3. Accuracy (Other than Room Sensor or Averaging) minimum $\pm 0.65^\circ\text{F}$.
 - 4. Range minimum $-40 - 220^\circ\text{F}$.
- E Temperature Transmitter:
 - 1. Accuracy minimum $\pm 0.1^\circ\text{F}$ or $\pm 0.2\%$ of span.
 - 2. Output 4-20 mA.
- F Provide limited range or extended range sensors if required to sense the range expected for a respective point. Use RTD type sensors for extended ranges beyond -30 to 230°F . If RTD's are incompatible with DDC controller direct temperature input use temperature transmitters in conjunction with RTD's.
- G Use wire size appropriate to limit temperature offset due to wire resistance to 1.0°F . If offset is greater than 1.0°F due to wire resistance, use temperature transmitter. If feature is available in DDC controller, compensate for wire resistance in software input definition.
- H Provide sensors in occupied spaces with brushed aluminum or brushed nickel covers unless otherwise noted or features specified will not allow for this. Terminal unit sensors with setpoint adjustments and digital displays may use plastic covers. Provide information to the Engineer on sensor colors offered by the manufacturer and obtain approval on what color should be provided on the project.
- I Terminal unit sensors shall be provided with digital displays that indicate room temperature and setpoint and have a manual occupancy override and indication of occupancy status. Provide setpoint adjustment as specified in the Input / Output Summary and sequence of operation.
- J Use averaging elements on duct sensors when the ductwork is ten square feet or larger. All mixed air and heating coil discharge sensors shall have averaging elements regardless of duct size.
- K In piping systems use temperature sensors with separable wells designed to be used with temperature element.

2.10 HUMIDITY SENSORS

- A Use capacitive thin-film polymer sensor types with a range of 0-100% RH. Accuracy to be no less than **[+/-2%]** in the range of 20% RH to 80% RH with a response time of 120 seconds or less. Provide covers for room humidity sensors as specified for temperature sensors.
- B For outside air applications, use sensor designed for outside air use along with weather enclosure. Provide sensor equal to Vaisala Model HMD60UO with DTR503B enclosure and weather resistant mounting hardware.

2.11 AIR PRESSURE TRANSDUCERS

- A Provide pressure transducers specified below for the following applications:
 - 1. Duct static pressure applications where setpoints are specified to control at greater than 0.1" w.c.
 - 2. Pitot type fan inlet air flow stations.
 - 3. Terminal unit air flow measurement regardless of the minimum velocity pressure unless otherwise noted in the contract documents.

- B Manufacturers:
1. Mamac Systems: www.mamacsys.com.
 2. Setra: www.setra.com.
 3. Veris Industries: www.veris.com.
 4. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- C Provide a transmitter that operates on the capacitance principle and is capable of sensing low positive, negative or differential pressures. Transmitter shall have a minimum of three pressure ranges adjustable by an onboard switch or jumper. Size the transmitter where the middle or high range is suitable for the application. Use a bi-directional transmitter for applications that may have both positive and negative pressure excursions. Transmitter shall be provided with an integral four-digit display of the pressure sensed.
1. Accuracy (including non-linearity and hysteresis) $\pm 1\%$ FS.
 2. Compensated Temperature Range 32° - 140° F.
 3. Temperature Effect
0-1"wc Range .09% FS/ $^{\circ}$ F;
>1"wc Range .02% FS/ $^{\circ}$ F.
 4. Output 4-20 MA.
 5. Load Impedance (smallest maximum acceptable) 800Ω max.
 6. Operating Temperature 32° - 140° F.
- D Pressure transducers used for supply VAV box flow applications do not need to have adjustable pressure ranges or integral display.
- E Provide pressure transducers specified below for the following applications:
1. Duct static pressure applications where setpoints are specified to control at 0.1" w.c. or lower.
 2. All duct mounted pitot type air flow stations.
 3. Space/building static control or monitoring.
- F Manufacturers:
1. Paragon Controls; MicroTrans: www.paragoncontrols.com.
 2. Air Monitor; Veltron DPT2500 Plus: www.airmontor.com.
 3. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- G The airflow transducer shall provide noise filtration and automatic auto-zeroing. The automatic zeroing circuit shall be capable of maintaining the transducer output to within +/- 0.25% of operating span. The transducer output shall be locked and maintained at the last given output value during the automatic zeroing period so as not to interrupt the automatic control process. Use a bi-directional transmitter for applications that may have both positive and negative pressure excursions. Transmitter shall be provided with an integral four-digit display of the pressure sensed.
1. Transducer Span: <2 times the design velocity pressure at maximum flow, single range.
 2. Accuracy: $\pm 0.25\%$ of full scale, including non-linearity, hysteresis, deadband, and non-repeatability.
 3. Temperature Effect: $\pm 0.15\%$ of full scale/ $^{\circ}$ F.
 4. Response: 0.5 sec. for 98% of full span change.
 5. Overpressure: 5 PSIG Proof.
 6. Power: 24VAC/VDC.
 7. Analog Output: 0-5VDC, 0-10VDC, or 4-20mA field adjustable.
 8. Auto Zero Frequency: Every 1 to 24 hours on 1 hour intervals.

2.12 LIQUID / STEAM PRESSURE TRANSDUCERS

- A Provide a transmitter that utilizes capacitive or thin film strain gauge sensing. Provide for an analog gauge piped in parallel with the transducer. Gauge shall meet specifications as specified in Section 23 05 15. Coordinate with Mechanical Contractor to provide and install this gauge. For differential pressure applications provide with bypass valve manifold assembly with valved venting capability.
- | | |
|--|----------------|
| 1. Accuracy (including non-linearity and hysteresis) | ± 0.5% FS. |
| 2. Compensated Temperature Range | 32°-150 °F. |
| 3. Temperature Effect (over compensated range) | 0.03%/°F; |
| Output | 4-20 MA. |
| 4. Load Impedance (smallest maximum acceptable) | 600 Ω Minimum. |
| 5. Operating Temperature | 0°-175 °F. |
| 6. Hysteresis | 0.75% of span. |

2.13 AIR DIFFERENTIAL PRESSURE SWITCHES

- A Differential pressure switches shall sense both inlet and outlet of fans. Device shall be rated for 150% of maximum system pressures that may be encountered. Provide with pressure differential that will be required to meet specified operation and/or to prevent nuisance lockouts of the device in the system served.
- B Differential pressure switches shall be diaphragm type, with die-cast aluminum housing and adjustable set point. Switch rating shall be a minimum 5 amps at 120 VAC. Switches shall be SPDT and be used for fan status as specified in the Input / Output Summary. Switch pressure range shall be suited for application. (e.g. filter 0-2.0", fan status 0-5.0", fan static safety 0-5.0"). For fan static limit applications provide the device with manual reset.

2.14 LIQUID DIFFERENTIAL PRESSURE SWITCHES

- A Differential pressure type switches shall be UL listed, SPDT snap-acting, pilot duty rated for 125 VA minimum, NEMA 1 enclosure, with scale range and differential suitable for the intended application or as shown in the Input / Output Summary.

2.15 CURRENT STATUS SWITCHES

- A Provide a current sensor with adjustable threshold and digital output with LED display, equal to a Veris model H-708/H-904. Threshold adjustment must be by a multi-turn potentiometer or set by multiprocessor that will automatically compensate for frequency and amperage changes associated with variable frequency drives. When used on variable speed motor applications, use a current sensor that will not change state due to varying speeds.

2.16 CARBON DIOXIDE (CO₂) SENSOR (THESE DEVICES ARE USED WITH DDC SYSTEMS TO MONITOR / TREND CO₂ LEVELS AND CAN BE USED TO ADJUST VENTILATION / AIRFLOW RATES)

- A Provide a Carbon Dioxide (CO₂) sensor that shall utilize non-dispersive infrared (NDIR) technology. The sensor shall have a linear analog output over a range of 0-2000 ppm and have built in display of CO₂ level. The sensor shall have an automatic calibration algorithm that will compensate for sensor drift over time due to sensor element degradation. Unit shall be provided with a 0-10VDC or 4-20mA analog output that is selectable and a field adjustable relay alarm output. Accuracy shall be better than ±5% of reading or ±50ppm whichever is higher. The sensor shall be user calibratable with a minimum calibration interval of five years.

2.17 POWER SUPPLIES

- A Provide all required power supplies for transducers, sensors, transmitters and relays. All low voltage transformers shall have a resettable secondary circuit breaker and be listed as class 2 power supplies.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install system with trained mechanics and electricians employed by the control equipment manufacturer or an authorized representative of the manufacturer. Where Installing Contractor is an authorized representative of the control manufacturer, such authorization shall have been in effect for a period of no less than three years.
- B Install all control equipment, accessories, wiring, and piping in a neat and workmanlike manner. All control devices must be installed in accessible locations. This Contractor shall verify that all control devices furnished under this Section are functional and operating the mechanical equipment as specified in Section 23 09 93.
- C All cables to the electronic input/output devices, sensors, relays and interlocking wiring (all of which shall be supplied and installed under this section of specification) interfaced with the Direct Digital Control System shall be extended into the 23 09 23 DDC panel with a minimum of 5 ft. of cable to allow for termination by the DDC System Contractor. This Contractor shall provide a technician to inspect and validate all tubing, wiring, and field devices associated with the DDC interface in coordination with and under direction of the 23 09 23 DDC Contractor to ensure that each device is operating per the control sequences as specified in Section 23 09 93.
- D Label all control devices with the exception of dampers, valves, and terminal unit devices with permanent printed labels that correspond to control drawings. Temperature control junction and pullboxes shall be identified utilizing spray painted green covers. Other electrical system identification shall follow the 26 05 53 specification.
- E All control devices and electrical boxes mounted on insulated ductwork shall be mounted over the insulation. Provide mounting stand-offs where necessary for adequate support. Cutting and removal of insulation to mount devices directly on ductwork is not acceptable. This Contractor shall coordinate with the insulation Contractor to provide for continuous insulation of ductwork.
- F Mounting of electrical or electronic devices shall be protected from weather if the building is not completely enclosed. This Contractor shall be solely responsible for replacing any equipment that is damaged by water that infiltrates the building if equipment is installed prior to the building being enclosed.
- G Provide all electrical relays and wiring, line and low voltage, for control systems, devices and components. Install all high voltage and low voltage wiring (includes low voltage cable) in metal conduit, Electrical Non-metallic Tubing (ENT), or Electrical Metallic Tubing (EMT), as scheduled below and hereafter referred to generically as conduit. See Wire and Air Piping Conduit Installation Schedule below for specific conduit or tubing to be used. All conduit must be installed in accordance with electrical sections (Division 26) of this specification and the National Electrical code.
- H Conduit shall be a minimum of 1/2 inch for low voltage control provided the pipe fill does not exceed 40%.
- I Minimum low voltage wiring gauge to be 18 AWG for outputs and 20 AWG for inputs. All low voltage wiring to be stranded.
- J Low voltage wiring can be run without conduit above accessible lay-in tile ceilings. All wiring in mechanical rooms, above inaccessible hard ceilings, exterior locations, and in any exposed areas, and in all other locations should be in conduit.
- K Wire for wall sensors and radiation valves can be plenum rated cable.
- L Where wiring is installed free-air, installation shall consider the following:
 - 1. Wiring shall utilize the cable tray wherever possible.

2. Wiring shall run at right angles and be kept clear of other trades work.
 3. Wiring shall be supported utilizing "J" or "Bridal-type" steel mounting rings anchored to ceiling concrete, piping supports, walls above ceiling or structural steel beams. Mounting rings shall be of open design (not a closed loop) to allow additional wire to be strung without being threaded through the ring. For mounting rings that do not completely surround the wire, attach the wire to the mounting ring with a strap.
 4. Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If wiring "sag" at mid-span exceeds 6-inches; another support shall be used.
 5. Wiring shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires.
 6. Wall penetrations shall be sleeved.
- M Wiring shall not be attached to existing cabling, existing tubing, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.
- N Control panels serving equipment fed by emergency power shall also be served by emergency power. This Contractor shall be responsible for all 120VAC power, not provided in the Division 26 specifications, required for equipment provided under this section. Power shown for temperature control panels on plans may be utilized by the 23 09 23 and 23 09 14 Contractors.
- O Provide communication trunk wiring to integrated devices (i.e. VFD's, Flow Meters, Chillers, Lighting Panels, Electrical Meters, etc.) that are specified to be connected to the building automation system. Communication trunk wiring shall be as required by the equipment specified under the 23 09 23 sections and shall be routed to the DDC panel designated for that equipment as shown on the plans or the closest DDC panel if not designated. If communication trunks required daisy chained style wiring, provide two communication cables.
- P Install "hand/off/auto" selector switches on systems where automatic interlock controls are specified and "hand/off/auto" selector switches are not supplied with the equipment controlled. Control panel power will not be required for "hand" switch to operate. When switch is in "hand" position, allow manual operation of the selected device without operating the interlocked motors but allowing all unit safety devices to stay in the circuit.
- Q All electrical wiring are to be permanently tagged or labeled within one inch of terminal strip with a numbering system to correspond with the "Record Drawings".
- R Label all control components (valves, damper actuators, sensors...etc.) to match the 23 09 23 control submittals.
- S After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

3.02 CONTROL, COMBINATION FIRE / SMOKE, AND SMOKE DAMPERS

- A All dampers furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.
- B Coordinate installation with the sheetmetal installer to obtain smooth duct transitions where damper size is different than duct size. Blank off plates will not be accepted.
- C For control dampers, each operator shall serve a maximum damper area of 36 square feet. Where larger dampers are used, provide multiple operators.

3.03 CONTROL VALVES

- A All temperature control valves furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.

3.04 CONTROL SYSTEM INSTRUMENTATION

- A Install thermometers at each point of temperature transmission (sensors) and control, except reheat coils, unless the drawings indicate a thermometer is to be installed by the piping or sheetmetal installer. Install thermometers to permit easy reading from the floor or operating platform. Provide remote mounting or swiveled mounting as required for easy reading. Flush mounting where not easily read is not acceptable.

3.05 ELECTRIC / ELECTRONIC ROOM THERMOSTATS

- A Check and verify location of thermostats and humidistats with plans and room details before installation. Locate room thermostats 60 inches above floor for non-adjustable and 48 inches above floor for all adjustable devices. Align with light switches and humidistats. For drywall installations, thermostat mounting shall use a back-box attached to a wall stud, drywall anchors are not acceptable.
- B Any room thermostats mounted on an exterior wall shall be mounted on a thermally insulated sub-base. Subbase to provide a minimum of one half inch of insulation.
- C Where thermostats or sensors are mounted on exterior walls or in any location where air transfer will affect the measured temperature or humidity seal the conduit and any other opening that will affect the measurement.
- D Provide guards on thermostats in entrance hallways, other public areas, or in locations where thermostat is subject to physical damage.

3.06 TEMPERATURE CONTROL PANELS

- A Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide permanent printed labeling for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- B Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.

3.07 LOW LIMIT THERMOSTATS (Freezestats)

- A Install low limit controls where indicated on the drawings or as specified. Unless otherwise indicated, install sensing element on the downstream side of heating coils.
- B Mount units using flanges and element holders. Provide duct collars or bushings where sensing capillary passes through sheetmetal housings or ductwork; seal this penetration to eliminate air leakage. Mount the units in an accessible location as to allow for resetting after low limit trips while still meeting manufacturer's installation requirements for proper function.
- C Distribute (serpentine) sensing element horizontally across the coil to cover every square foot of coil; on larger coils this may require more than one instrument. Install controls at accessible location with mounting brackets and element duct collars where required.
- D For integral face and bypass coils the elements are to be run vertically on the face of the heating coil inside the damper enclosure, this will require drilling the frame to run element around the by-pass.

3.08 AIR FLOW STATIONS

- A Install airflow stations in accordance with manufacturer's recommendations. Install straightening vanes upstream of unit where required per manufacturers recommendations. Program local displays to read in cubic feet per minute. Coordinate calibration with the test and balance Contractor.

3.09 ROOM SENSORS

- A Check and verify location of sensors and humidity sensors with plans and room details before installation. Locate room sensors 60 inches above floor for non-adjustable and inches above floor for all adjustable devices. Align with light switches and humidity sensors. For drywall installations, thermostat mounting shall use a back-box attached to a wall stud, drywall anchors are not acceptable.
- B Any room sensors mounted on an exterior wall shall be mounted on a thermally insulated sub-base. Subbase to provide a minimum of one half inch of insulation.
- C Where sensors are mounted on exterior walls or in any location where air transfer will affect the measured temperature or humidity seal the conduit and any other opening that will affect the measurement.
- D Provide guards on sensors in entrance hallways, other public areas, or in locations where thermostat is subject to physical damage.

3.10 AIR AND WATER PRESSURE TRANSDUCERS

- A Install capped tees in air piping at air pressure transducers for connection of calibration equipment. Capped tee shall consist of two inch poly tubing capped with a brass plug. Rubber caps are not acceptable.
- B Install Pete's Plugs or acceptable fittings at each take-off from main piping for liquid pressure transducers for connection of calibration equipment for the purpose of device validation.
- C Install differential pressure transducers for filter monitoring at the filter section of the air handling unless otherwise specified. All other differential or static pressure transducers for air applications should be mounted in the temperature control panel serving the equipment being monitored. Duct static pressure transmitters can be remotely mounted if there location is noted on the record drawings. In addition, the device must be installed in an accessible location.
- D For steam and liquid applications, provide shutoff valves at piping takeoff points with test port for device testing.

3.11 AIR AND LIQUID DIFFERENTIAL PRESSURE SWITCHES

- A Provide for each fan or pump specified or shown on point list. Provide shutoff valves at piping takeoff points. Readjust pressure and/or differential setpoints for proper operation after final balancing is completed.
- B Differential or static pressure high limit switches can be mounted on the equipment served. All devices mounted on equipment shall be mounted in a location that is at a maximum of five feet above the floor.

3.12 WATER FLOW SWITCHES

- A Shall be installed by the Mechanical Contractor. It is the responsibility of this Contractor to ensure these devices are installed in accordance with the manufacturer's recommendations.

3.13 CURRENT STATUS SWITCHES

- A Provide for each fan or pump specified or shown on the Input / Output summary. Set threshold adjustment to indicate belt or coupling loss. Readjust threshold for proper operation after final balancing is completed. Use the variable frequency drive (VFD) integrated relay output for motor status, if provided on the VFD, in lieu of a discrete current switch. A separate current switch provided under this section shall be wired in parallel with the VFD motor status relay when a bypass starter is provided on the VFD to prove motor status in the bypass mode.

3.14 CARBON DIOXIDE SENSORS

- A Install in accordance with manufacturer's recommendations.

3.15 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction checklists supplied by the commissioning authority under specification Section 23 08 00 in accordance with the procedures defined in that section.

3.16 OWNER TRAINING

- A Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 8 hours.

END OF SECTION 23 09 13

SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC
(New System – Competitive Bid)

PART 1 GENERAL

1.01 SCOPE

- A Work in this section includes Direct Digital Control (DDC) panels, main communication trunk, software programming, and other equipment and accessories necessary to constitute a complete Direct Digital Control (DDC) system. This system interfaced with electric controls (Section 23 09 13) utilizing Direct Digital Control signals to operate actuated control devices will meet, in every respect, all operational and quality standards specified herein.
- B SYSTEM DESCRIPTION:
 - 1. This project will require a basic graphic workstation for adjusting setpoints and monitoring system status. Software to be installed on the Owner's server-based network. The Owner will require remote web-based access to the system for after hour monitoring and control adjustments.
- C PROJECT SPECIFIC COORDINATION REQUIREMENTS:
 - 1. PART 1 - GENERAL
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Submittals.
 - g. Operation and Maintenance Data.
 - h. Material Delivery and Storage.
 - i. Warranty.
 - 2. PART 2 - PRODUCTS
 - a. General.
 - b. Manufacturers.
 - c. Local Control Panels.
 - d. Direct Digital Controls (DDC).
 - e. Networking/Communications.
 - f. Integrated Communications to Third Party Equipment.
 - g. Supervisory Controllers.
 - h. System Software Features.
 - i. Programmable Controllers.
 - j. Application Specific Controllers – HVAC Applications.
 - k. Operator Interface Requirements.
 - l. Operator Workstation & DDC Server.
 - m. Web Based HTML Browser Interface.
 - n. Portable Operator Terminal.
 - o. ASC Portable Service Terminal.

3. PART 3 - EXECUTION
 - a. General.
 - b. Installation.
 - c. Owner Training.
 - d. Demonstration Testing.

1.02 RELATED WORK

- A Applicable provisions of Division 1 govern work under this Section.
- B Section 01 91 01 - Commissioning Process.
- C Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC – Coordination.
- D Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- E Section 23 09 93 - Sequence of Operation for HVAC Controls.
- F Input / Output Summary – See project drawings.
- G Division 23 - HVAC - Equipment provided to be controlled or monitored.
- H Division 26 - Electrical - Equipment provided to be controlled or monitored.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A FCC Part 15, Subpart J, Class A - Digital Electronic Equipment to Radio Communication Interference

1.05 QUALITY ASSURANCE

A MANUFACTURER:

1. A firm regularly engaged in manufacture of DDC control equipment similar to the specified equipment and has been in satisfactory similar service for not less than 5 years.

B INSTALLER:

1. A firm specializing and experienced in DDC control system installation for no less than 3 years. All work shall be done by qualified mechanics in the direct employ of this manufacturer, or of an Authorized Representative of that manufacturer that provides engineering and commissioning of the manufacturers control equipment. Where installing Contractor is an authorized representative of the control equipment manufacturer, submit written confirmation of such authorization. Indicate in letter of authorization that the installing Contractor has successfully completed all necessary training required for the engineering, installation, and commissioning of equipment and systems to be provided for the project, and that such authorization has been in effect for a period of not less than three years.

C RESPONSE TIME:

1. During warrantee period, four (4) hours or less, 24-hours/day, 7 days/week.

D ELECTRICAL STANDARDS:

1. Provide electrical products, which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.

- E DDC Standards: DDC manufacturer shall provide written proof with shop drawings that the equipment being provided is in compliance with F.C.C. rules governing the control of interference caused by Digital Electronic Equipment to Radio Communications (Part 15, Subpart J, Class A).

1.06 SUBMITTALS

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

B PRODUCT DATA:

1. Submit manufacturer's specifications for each control device furnished, including installation instructions and startup instructions.

2. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked. Annotated software program documentation shall be submitted for system sequences, along with descriptive narratives of the sequence of operation of the entire system involved. Submit wiring diagram for each electrical control device along with other details required to demonstrate that the system has been coordinated and will function as a system.
- C MAINTENANCE DATA:
1. Submit maintenance data and spare parts lists for each control device. Include this data in maintenance manual.
- D RECORD DRAWINGS:
1. Prior to request for final payment provide complete composite record drawings to incorporate the DDC and Electric field work.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.08 MATERIAL DELIVERY AND STORAGE

- A Provide factory shipping cartons for each piece of equipment and control device. This Contractor is responsible for storage of equipment and materials inside and protected from the weather.

1.09 WARRANTY

- A Provide a 1-year warranty on all materials and workmanship.

PART 2 PRODUCTS

2.01 GENERAL

- A Provide DDC control products in sizes and of capacities as required, conforming to manufacturer's standard materials and components as published in their product information, designed, and constructed as recommended by the manufacturer and as required for application indicate.
- B System shall be capable of operating with 120 VAC power supply, fully protected with a shutdown-restart circuit, and associated hardware and software.

2.02 MANUFACTURERS

- A Trane: www.trane.com.
- B Johnson Controls: www.johnsoncontrols.com.
- C Honeywell: www.honeywell.com.
- D Siemens: www.siemens.com.
- E Andover: www.andovercontrols.com.
- F Alerton: www.alerton.com.
- G Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.03 LOCAL CONTROL PANELS

- A Use control panels with suitable mounting brackets for each supply fan system. Locate panel adjacent to system served.
- B Fabricate panels of 14-gauge furniture grade steel or 6063-T5 extruded aluminium alloy, totally enclosed on six sides, hinged door, and keyed lock, with manufacturer's standard shop painted finish and color.
- C Provide UL listed cabinets for use with line voltage devices.
- D Plastic control enclosures will be approved provided all conduits are bonded and grounded.
- E Provide control panels for all DDC Controllers, ASC's, and associated function modules. All controls to be in panels except for terminal unit controllers mounted within the terminal unit equipment enclosure or VAV box controllers designed to be directly mounted on air terminals.

- F Provide terminal unit equipment enclosures with removable cover for all terminal units located in exposed ceilings that completely enclose the DDC controller and allow for conduit terminations.
- G Permanently label all controls; tag all control wiring.

2.04 DIRECT DIGITAL CONTROLS

- A System to be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection.
- B DDC to consist of Supervisory Controllers, Programmable Controllers, stand-alone ASCs (ASC's), Operators Terminals, Operator Workstations, DDC system servers, and other operator interface devices.
- C The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASC's, and operator devices.
- D The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2.05 NETWORKING/COMMUNICATIONS

- A Contractor to coordinate with the Owner's information technology staff or provider.
- B The design of the DDC shall be networked. Inherent in the system's design shall be the ability to expand or modify the network.
- C The DDC communications network shall be capable of direct connection to and communication with a high-speed local area network (LAN) such as ARCNET or Ethernet.
- D The supervisory controller shall directly oversee a local network such that communications may be executed directly to and between programmable controllers and ASC's. All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all points and application reports on the network.
- E Provide RS-232 ports on all ASC's for operator's terminal communications with the DDC Controller from any ASC on the network.
- F Access to system data shall not be restricted by the hardware configuration of the DDC system.
- G Global data sharing or global point broadcasting shall allow point data to be shared between programmable controllers and ASC's when it would be impractical to locate multiple sensors.
- H Network design shall include the following provisions:
 1. Data transfer rates for alarm reporting and quick point status from multiple programmable controllers and ASC's. The minimum data transfer speed shall be 19.2Kb.
 2. Data transfer medium shall be fiber optic or a single pair of solid 24 gauge twisted, shielded copper cable.
 3. Support of any combination of programmable controllers and ASC's. A minimum of 32 programmable controllers and ASC's shall be supported on a single local network. The buss shall be addressable for up to 32 ASC's.
 4. Detection of single or multiple failures of ASC's or the network media.
 5. Error detection, correction, and re-transmission to guarantee data integrity.
 6. Use commonly available, multiple-sourced, networking components.
 7. Use of an industry standard communication transport, such as, ARCNET, Ethernet, and IEEE RS-485 communications interface.

2.06 INTEGRATED COMMUNICATIONS TO THIRD PARTY EQUIPMENT

- A Integrated communications to the following equipment will be required by this Contractor:
 1. Boilers.
 2. Indoor AHU units (Split DX Cooling Units on Roof).
 3. Variable frequency drives.

- B This Contractor will be required to coordinate communication protocol used with each equipment manufacturer adherence to industry standards including ANSI/ASHRAE Standard 135-2001, BACnet, Lon Mark, or MODBUS will be required to assure interoperability between the DDC system all equipment specified for integrated communications.

2.07 SUPERVISORY CONTROLLERS

- A Supervisory controllers shall be microprocessor-based, multi-tasking, multi-user and digital control processors.
- B Each supervisory controller shall have sufficient memory to support its own operating system and databases including:
 1. Control processes.
 2. Energy management application.
 3. Alarm management.
 4. Trend data.
 5. Maintenance support applications.
 6. Operator I/O.
 7. Dial-up, network, and web-based communications.
 8. Manual override monitoring.
- C The system shall be modular in nature and shall permit easy expansion through the addition of field controllers, sensors, and actuators.
- D Supervisory controllers shall provide at least two RS-232C or USB serial communication ports or Ethernet ports for simultaneous operation of multiple operator I/O devices, such as laptop computers, personal computers, and video display terminals.
- E Supervisory controllers shall monitor the status of all overrides and include this information in the logs and summaries to inform the operator that automatic control has been inhibited.
- F Each supervisory controller shall continuously perform self-diagnostics, communications diagnostics, and diagnostics of all subsidiary equipment. Supervisory controllers shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each supervisory controller.
- G Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high to allow all signal wiring to be run in the same conduit as high voltage wiring acceptable by electrical code.
- H In the event of the loss of normal power, there shall be an orderly shutdown of the supervisory controller to prevent the loss of data base 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 72 hours.
- I Upon restoration of normal power, the supervisory controller shall automatically resume full operation without manual intervention.
- J Should supervisory controller memory be lost for any reason, the supervisory controller shall have the capability of reloading it's programming via high-speed local area network from the control system archive workstation or server, the local RS-232C port, or telephone line dial-in.

2.08 SYSTEM SOFTWARE FEATURES

- A All necessary software to form a complete operating system, as described in this specification, shall be provided as an integral part of the supervisory controller, and shall not be dependent upon higher level computer for execution.

- B Control software shall include a provision for limiting the number of times that each piece of equipment may be cycled within any one-hour period.
- C The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
- D Supervisory controllers shall have the ability to perform any or all of the following energy management routines:
 - 1. Time of day scheduling.
 - 2. Calendar based scheduling.
 - 3. Holiday scheduling.
 - 4. Optimal start.
 - 5. Optimal stop.
 - 6. Demand limiting.
 - 7. Load rolling.
 - 8. Heating/cooling interlock.
- E All programs to be executed automatically without the need for operator intervention and be flexible enough to allow user customization. Programs shall be applied to building equipment described in Section 23 09 93 of this specification.
- F Supervisory controllers shall be able to execute configured processes defined by the user to automatically perform calculations and control routines.
- G It shall be possible to use any of the following in a configured process:
 - 1. Any system-measured point data or status.
 - 2. Any calculated data.
 - 3. Any results from other processes.
 - 4. Boolean logic operators (and, or).
- H Configured processes may be triggered based on any combination of the following:
 - 1. Time of day.
 - 2. Calendar date.
 - 3. Other processes.
 - 4. Events (e.g., point alarms).
- I A single process shall be able to incorporate measured or calculated data from any and all other ASC's.
- J A single process shall be able to issue commands to points in any and all other programmable controllers and ASC's on the local network.
- K Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each supervisory controller shall perform distributed; independent alarm analysis and filtering to minimize network traffic and prevent alarms from being lost. At no time shall the ability of supervisory controllers to report alarms be affected by either operator activity at the local I/O device or communications with other ASC's on the network.
- L All alarm or point change reports shall include the English language description of each point and the time and date of the occurrence.
- M The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Users shall have the ability to manually inhibit alarm reporting for each point.

- N The user shall also be able to define conditions under which point changes need to be acknowledged by an operator and/or logged for analysis at a later date.
- O Alarms reports and messages shall be directed to an operator device.
- P In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 60-character alarm message to more fully describe the alarm condition or direct operator response.
- Q Each supervisory controller shall be capable of storing a library of at least 100 messages. Each message may be assignable to any number of points in the panel.
- R A data collection utility shall be provided to automatically sample, store, and display system data.
- S Measured and calculated analog and binary data shall be assignable to user definable trends for the purpose of collecting operator specified performance data over extended periods of time. Sample intervals of 1 minute to 24 hours, in one minute or one hour intervals, shall be provided. Each supervisory controller shall have a dedicated buffer for trend data and shall be capable of storing 16 trend logs. Each trend log shall have up to four points trended at 48 data samples each. Data shall be stored at the supervisory controller and up-loaded to the DDC system server when archiving is desired.
- T Supervisory controllers shall automatically accumulate and store runtime hours for binary input and output points specified in Section 23 09 13 of this specification.
- U Supervisory controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis, user defined, for user-selected analog and binary pulse input type points.
- V Totalization shall provide calculation and storage accumulations of up to 9,999,999 units (e.g., KWH, gallons KBTU, tons, etc.).
- W The totalization routine shall have a sampling resolution of one minute.
- X The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.
- Y The information available from pulse totalization shall include, but not be limited to, the following:
 - 1. Peak demand, with date and time stamp.
 - 2. 24-hour demand log.
 - 3. Accumulated KWH for day.
 - 4. Sunday through Saturday KWH usage.
 - 5. Demand KW annual history for past 12 periods.
 - 6. KWH annual history for past periods.
- Z Supervisory controllers shall have the ability to count events, such as the number of times a pump or fan system is cycled on and off.
- AA The event totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

2.09 PROGRAMMABLE CONTROLLERS

- A Programmable controllers shall be provided with a software program that shall allow the user to design flexible software algorithms for the control sequences as described in Sections 23 09 13 and 23 09 93 portions of this specification.
- B Programmable controllers shall support all necessary point inputs and outputs to perform the specified control sequence in a totally stand-alone fashion.
- C Each programmable controller shall perform own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

- D Each programmable controller shall support the use of a locally mounted status and adjust panel interface to allow for the local adjustment of all setpoints, temporary override of any input or output points and status of all points directly at the controller. The capabilities of the locally mounted status and adjust panel shall include, but not be limited to, the following information for the programmable controllers to which:
 - 1. Display temperatures.
 - 2. Display status.
 - 3. Display setpoints.
 - 4. Display control parameters.
 - 5. Override binary output control.
 - 6. Override analog setpoints.
 - 7. Modification of gain and offset constants.
- E All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the programmable controller.
- F Programmable controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 13 and 23 09 93 portions of this specification, and for future expansion of air handling units:
 - 1. Air handling units.
 - 2. Boiler plants.
 - 3. Hot water distribution systems.

2.10 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS

- A Each supervisory controller shall be able to extend its monitoring and control through the use of stand-alone ASCs.
- B Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor based, multi-tasking, real-time digital control processor.
- C Each ASC shall have sufficient memory to support its own operating system and databases including:
 - 1. Control Processes.
 - 2. Energy Management Applications.
 - 3. Operator I/O (Portable Service Terminal).
- D The operator interface to any ASC point or program shall be through the supervisory controller connection to any ASC on the network.
- E ASC's shall directly support the temporary use of a portable service terminal that can be connected to the ASC via zone temperature or directly at the controller. The capabilities of the portable service terminal shall include, but not be limited to, the following information for the:
 - 1. Display temperatures.
 - 2. Display status.
 - 3. Display setpoints.
 - 4. Display control parameters.
 - 5. Override binary output control.
 - 6. Override analog setpoints.
 - 7. Modification of gain and offset constants.

- F All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.
- G ASC's shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 13 and 23 09 93 portions of this specification, and for future expansion of air handling units:
 - 1. Variable Air Volume Boxes.
 - 2. Reheat Coils.
- H The following ASC's will be field installed by this Contractor:
 - 1. Variable Air Volume Boxes.
 - 2. Reheat Coils.

2.11 OPERATOR INTERFACE REQUIREMENTS

- A COMMAND ENTRY/MENU SELECTION PROCESS:
 - 1. Operator interface software shall minimize operator training through the use of English language prompting and English language point identification.
- B TEXT-BASED DISPLAYS:
 - 1. The operator interface shall provide consistent text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.
- C GRAPHIC-BASED DISPLAYS:
 - 1. The operator interface shall provide graphic based displays of each system. The point data associated with each system shall dynamically update at a minimum of every 30 seconds. Graphic displays shall be linked to each other to provide a "drill down" capability from main graphic displays to more specific system-based displays. Provide a building level graphic display that links to system graphics. For systems that have ASC controlled terminal unit controls, provide a building floor plan with dynamic temperatures shown on the graphic that can be expanded into for more specific terminal unit information.
- D PASSWORD PROTECTION:
 - 1. Multiple-level password access protection shall be provided to allow the user/manager to limit control, display, and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.
 - 2. Passwords shall be exactly the same for all operator devices.
 - 3. A minimum of three levels of access shall be supported:
 - a. Level 1: Operator has access to system data, displays, and setpoints for viewing only
 - b. Level 2: Operator can override end device commands, acknowledge alarms, and change system setpoints
 - c. Level 3: Operator can modify database and control programs
 - 4. A minimum of 4 passwords shall be supported at each supervisory controller.
 - 5. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only those items defined for the access level of the password used to log-on.
 - 6. Provide user definable, automatic log-off timers of from 1 to 60 minutes to prevent operators from inadvertently leaving devices on-line.

E OPERATOR COMMANDS:

1. The operator interface shall allow the operator to perform commands including, but not limited to, the following:
 - a. Start-up or shutdown selected equipment.
 - b. Adjust setpoints.
 - c. Add/modify/delete time programming.
 - d. Enable/disable process execution.
 - e. Lock/unlock alarm reporting for each point.
 - f. Enable/disable totalization for each point.
 - g. Enable/disable trending.
 - h. Enter temporary override schedules.
 - i. Define holiday schedules.
 - j. Change time/date.
 - k. Enter/modify analog alarm limits.
 - l. Enable/disable analog alarm limits.
 - m. Enable/disable demand limiting.
 - n. Enable/disable duty cycle.

F LOGS AND SUMMARIES:

1. Reports shall be generated manually and directed to the displays. As a minimum, the system shall allow the user to easily obtain the following general listing of all points in the system that shall include, but not be limited to:
 - a. Points currently in alarm.
 - b. Off-line points.
 - c. Points currently in override status.
 - d. Points in weekly schedules.
 - e. Holiday programming.
2. Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration on the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

G SYSTEM CONFIGURATION AND DEFINITION:

1. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.
2. The system shall be provided complete with all equipment, software, and documentation necessary to allow an operator to independently perform the following functions:
 - a. Add/delete/modify ASCs.
 - b. Add/delete/modify points of any type, and all associated point parameters, and tuning constants.
 - c. Add/delete/modify alarm reporting definition for each point.
 - d. Add/delete/modify energy management applications.
 - e. Add/delete/modify time and calendar-based programming.
 - f. Add/delete/modify totalization for every point.

- g. Add/delete/modify historical data trending for every point.
- h. Add/delete/modify configured control processes.
- i. Add/delete/modify dial-up telecommunication definition.
- j. Add/delete/modify all operator passwords.
- k. Add/delete/modify alarm messages.

H PROGRAMMING DESCRIPTION:

- 1. Definition of operator device characteristics, ASC's, individual points, and shall be performed through fill-in-the-blank templates.

I NETWORK-WIDE STRATEGY DEVELOPMENT:

- 1. Inputs and outputs for any process shall not be restricted to a single ASC but shall be able to include data from any and all other ASC's to allow the development of network-wide control strategies.

J SYSTEM DEFINITION/CONTROL SEQUENCE DOCUMENTATION:

- 1. All portions of system definition shall be self-documenting and be capable of providing hardcopy printouts of all configuration and application data.

K DATA BASE SAVE/RESTORE/BACK-UP:

- 1. Backup copies of all programmable controller, ASC and supervisory controller databases shall be stored in at least one personal computer or laptop. Users shall also have the ability to manually execute downloading of a programmable controller, ASC, or supervisory controller database.

2.12 WEB BASED HTML BROWSER INTERFACE

- A Provide a HTML based browser interface (Web Server) for accessing the DDC system. This shall include all hardware and software to provide an Ethernet twisted pair connection to the Owners local or wide area network (LAN or WAN) that can be used to access the DDC system through a standard internet browser.
- B All information shall be provided to the Owner's IT staff to facilitate connection through the Owners LAN/WAN.
- C At a minimum, this interface shall be capable of all functions described under the Operator Interface section, Password Protection, Operator Commands, and Logs and Summary subsections of this specification.

2.13 PORTABLE OPERATOR TERMINAL

- A Provide a portable interface for accessing the DDC system from a connection to a supervisory controller. This device shall, at a minimum, be capable of all functions described under the Operator Interface section, Password Protection, Operator Commands, and Logs and Summary subsections of this specification.

2.14 ASC PORTABLE SERVICE TERMINAL OR SOFTWARE

- A Provide a portable service terminal capable of interfacing to ASC's through a local serial port located on the ASC or if a remote thermostat is provided for the ASC, at the thermostat. The service terminal shall be capable of displaying all input and output points, adjusting all setpoints, and all tuning parameters for the ASC. This device is primarily for setup and servicing of ASC's.

PART 3 EXECUTION

3.01 GENERAL

- A All electronic work required as an integral part of the Direct Digital Control system work is the responsibility of this section unless specifically indicated otherwise in this section, Section 23 09 13, or in Division 26.

- B This Contractor shall provide all labor, materials, engineering, software, permits, tools, checkout, and certificates required to install a complete Direct Digital Control system as herein specified.
- C Any and all points added with this project shall be grouped for display purposes into the system such that all points associated with a new or existing DDC system can appear together on the CRT display or printed log. Assignment of points to a group shall not be restricted by hardware configuration of the points of direct digital control. It shall be possible to assign a point to appear in more than one system. An English descriptor and an alpha/numeric identifier shall identify each system.
- D This Direct Digital Control system as herein specified shall be fully integrated and completely installed by this section. It shall include all required computer CPU software and hardware. Include the engineering, installation, supervision, calibration, software programming, and checkout necessary for a fully operational system.

3.02 INSTALLATION

- A All work and materials are to conform in every detail to the rules and requirements of the National Electrical Code and present manufacturing standards. All wiring and cable installation shall conform with the wiring installation as specified in the installation section of Section 23 09 13. All material shall be UL approved.
- B Install system and materials in accordance with manufacturer's instructions, rough-in drawings, and details on drawings.
- C Line voltage wiring to power the DDC Controllers, not provided by the Division 26 Contractor, to be by this Contractor.
- D Control panels serving equipment fed by emergency power shall also be served by emergency power.
- E Provide uninterruptable power supplies where necessary to provide proper startup of equipment or to accomplish power restart control sequences specified.
- F Mount control panels adjacent to associated equipment on vibration-free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.
- G Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.
- H Cable tray routing of the communication trunks is acceptable.
- I All tubing, cable and individual wiring is to be permanently tagged, with numbers corresponding with "Record Drawings", spares are to be labeled as "Spare".
- J Provide technician to work with air balancing Contractor and/or provide balancing Contractor with necessary hardware to over-ride DDC controllers for air balancing and establishing differential pressure setpoints for air and water distribution systems. In addition, the control technician shall be present to calibrate air and water flow measuring stations.
- K Provide documentation to demonstrate that all points, input, and output, have been checked out and verified operational, note any points not operating properly with notation of reason.

3.03 OWNER TRAINING

- A All training provided for the Owner shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 - Commissioning Process.
- B Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 16 hours.
- C Provide two follow-up visits for troubleshooting and instruction, one six months after substantial completion and the other at the end of the warranty period.

- D Length of each visit to be not less than 8 hours or the time necessary to provide required information and complete troubleshooting and inspection activity for all controls installed under 23 09 13, and 23 09 93. Coordinate the visit with the Owner/Agency and provide an inspection report to the Owner of any deficiencies found.

3.04 DEMONSTRATION TESTING

- A This Contractor shall include 16 hours for their technician to be on-site to demonstrate functionality of the following systems for the engineer of record:
 - 1. Air handling units.
 - 2. Boiler plants.
 - 3. Hot water distribution systems.
- B This Contractor shall include a minimum of 16 hours to assist the section 23 05 93 Contractor with the testing requirements defined in that section.

END OF SECTION 23 09 23

INTENTIONALLY LEFT BLANK

SECTION 23 09 93

SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SCOPE

- A This section includes control sequences for HVAC equipment as well as equipment furnished by others that may need monitoring or control. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Description of Work.
 - e. Submittals.
 - f. Operation and Maintenance Data.
 - g. Design Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Not Applicable.
 - 3. PART 3 – EXECUTION.
 - a. Control Sequences.
 - b. Heating Water Pump Control.
 - c. Secondary Heating Loop Pump (HWP-1) and Pump (HWP-2) Control.
 - d. Terminal Unit Control – DDC and Electric.
 - e. Variable Volume Mixed Air Handling Unit Control.
 - f. Functional Performance Testing.

1.02 RELATED WORK

- A Applicable provisions of Division 1 govern work under this Section.
- B Section 01 91 01 - Commissioning Process.
- C Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC - Coordination.
- D Section 23 09 13 - Electric Instrumentation and Control Devices for HVAC.
- E Section 23 09 23 - Direct Digital Control System for HVAC.
- F Division 23 - HVAC - Equipment provided to be controlled or monitored.
- G Division 26 - Electrical - Equipment provided to be controlled or monitored.

1.03 REFERENCE

- A Section 23 09 13 work includes furnishing and installing all field devices, including electronic sensors for the DDC of this section, equipment, and all related field wiring, interlocking control wiring between equipment, pneumatic tubing, sensor mounting, etc., that is covered in that section.
- B Motorized control dampers and actuators, thermowells (temperature sensing wells), automatic control valves and their actuators are also covered in Section 23 09 13.

1.04 DESCRIPTION OF WORK

- A Control sequences are hereby defined as the manner and method by which automatic controls function. Requirements for each type of operation are specified in this section.
- B Operation equipment, devices and system components required for automatic control systems are specified in other Division 23 control sections of these specifications.

- C All temperature, humidity, and pressure sensing, and all other control signal transportation for the control sequences shall be furnished under Section 23 09 13.
- D All pneumatic, electronic, and electric input/output signals shall be extended under Section 23 09 13, with adequate lead length for termination within the appropriate control panel being provided under 23 09 23.
- E Sequences for equipment controlled by Direct Digital Controls (DDC) as specified are accomplished by hardware and software provided under Section 23 09 23. Sequences for equipment controlled by pneumatic or electric self-contained controls are accomplished by hardware provided under Section 23 09 13.

1.05 SUBMITTALS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures
- B Section 23 05 00 and Sections 23 09 23 and 23 09 13 for descriptions of what should be included in the submittals.
- C Shop drawings shall be provided by Contractor(s) providing equipment under Sections 23 09 23 and 23 09 13. The Contractor providing the DDC equipment shall provide a complete narrative of the sequence of operations for equipment that is controlled through the DDC system. The Contractor providing the 23 09 13 equipment shall provide a complete narrative of the sequence of operation for equipment that is controlled directly from that equipment (without control logic through the DDC system). The narrative of the sequence of operation shall not be a verbatim copy of the sequences contained herein but shall reflect the actual operation as applied by the Contractor.

1.06 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.07 DESIGN CRITERIA

- A Reference Section 23 09 13.

PART 2 PRODUCTS

- A Not applicable to this Section – reference Sections 23 09 23 and 23 09 13 for product descriptions.

PART 3 EXECUTION

3.01 CONTROL SEQUENCES

- A SETPOINTS:
 - 1. All setpoints indicated in the control specification are to be adjustable. The setpoints shall be readily available to be modified in the mechanical system software system summary (either textual or graphic based) and under the same software level as hardware points. Some less used setpoints may be provided on a lower software level, if requested by the Owner for clarity. The setpoints indicated herein are only specified as a calculated starting point (or initial system operation). It is expected that setpoint adjustments and control loop tuning shall be required to provide optimum system operation based on requirements of the building. The control Contractor shall work with the balancing Contractor and the Owner to provide the final system setpoint adjustments and control loop tuning after the system is in operation and building is in use. Document all final setpoints on the as-built control drawings. Any questions regarding the intended operation of the HVAC equipment and control systems shall be referred to the HVAC design engineer through the appropriate construction communication process. The following setpoints should be used as initial setpoints unless otherwise specified in the individual control sequences:
 - a. Occupied Space Terminal Unit Heating: 68 °F.

- b. Occupied Space Terminal Unit Cooling: 74 °F.
- c. Entry Way Heating: 60 °F.
- d. Mechanical or Unoccupied Space Ventilation: 82 °F.
- e. Mechanical or Unoccupied Space Heating: 60 °F.

B ANTI-CYCLING:

1. When HVAC equipment or a sequence is specified to be started and stopped by a temperature, humidity, pressure setpoint or any other controlled variable, there shall be an adjustable differential setpoint that shall be set to prevent short cycling of the systems and equipment due to minor changes in the controlled variable. Temperature differential setpoints shall be set at 2 °F and non-temperature setpoints shall be set at 10% of the controlled range unless otherwise specified. Setpoints shall indicate at when the process should be turned on. Heating and cooling differentials shall be set for above setpoint and will be used to turn the process off. For example, an economizer sequence called to switch at 68 °F, would turn on at 68 °F and off at 70 °F since it is a cooling function. A heating lockout setpoint of 50 °F would turn on heating control at 50 °F and off at 52 °F Non-temperature differentials shall be set above setpoint if the setpoint is indicating a minimum value or below setpoint if the setpoint is indicating a maximum value. Provide minimum runtime timers for loads that are cycled to prevent over-cycling. Timers shall be set as specified or as needed to prevent damage or excessive wear to the equipment. Unless otherwise specified in the individual control sequences, fans and pumps shall have a minimum runtime on timers of 15 minutes (adj.) and off timers of 5 minutes (adj.). Safeties shall override runtime timers.

C DEADBANDS:

1. Provide deadbands for all DDC control loops to prevent constant hunting of output signals to controlled devices. Deadbands shall be set to provide adequate control around setpoint as follows unless otherwise specified in the individual control sequences:
 - a. Temperature Control: ± 0.5 °F.
 - b. Humidity Control: $\pm 1\%$ RH.
 - c. Airflow Control: $\pm 2\%$ of total flow.
 - d. AHU Static Pressure Control: ± 0.01 in. w.c.

D ALARMS:

1. Provide all alarmed points with adjustable time delays to prevent nuisance tripping under normal operation and on equipment start-up. Provide alarms on all points as indicated on point charts. For existing campus automations systems, add/delete what is called on the point charts for after consultation with user Owner to provide consistent alarming throughout the automation system.

E EQUIPMENT START/STOP FAILURE STATES:

1. All start/stop points for equipment shall utilize normally open contacts unless called out specifically in the individual control sequences.

F LEAD/LAG SEQUENCING:

1. For sequences that call for lead/lag of equipment connected to building automation systems, the lead device shall be able to be chosen through a selectable day of the week and time of day through the building automation system. Coordinate with the Owner for scheduling switchover and frequency. Unless otherwise directed, switchover shall occur at 10 A.M. Tuesday and shall rotate the lead device on a weekly cycle rotating through all devices sequentially. For standalone lead/lag sequence controllers (non-DDC), the lead device shall be selected by a switch on the panel face.

- G VARIABLE FREQUENCY DRIVE (VFD) MOTOR RUN STATUS:
1. Use the VFD programmable relay dry contact output specified to be provided with the VFD under Section 23 05 14 to prove motor run status and detect belt loss or coupling break. If a bypass contactor is provided with the VFD, provide an adjustable current switch and wire it in parallel with the VFD output for proving motor status.
- H VFD BYPASS & SAFETY INTERLOCKS:
1. VFD's equipped with bypass starters shall be interlocked so that the start/stop and safety circuits that are called out for VFD operation shall be functional when the VFD is indexed to the bypass starter mode. Unless otherwise specified in the sequence below, the switch from inverter to bypass starter modes shall be through a manual switch provided on the VFD/bypass starter package.
- I VFD MINIMUM SPEED:
1. The VFD start-up technician shall work with the Temperature Control Contractor to determine the minimum speed required for the motor controlled by the VFD to provide cooling of the motor as installed to prevent heat related problems. This minimum speed shall be set in the VFD controller.
- J CURRENT SWITCH SETUP:
1. When current switches are used for proving fan or pump status, they shall be set up so that they will detect belt or coupling loss by the reduction in current draw on loss of coupled load. The current switch set up shall be redone by the 23 09 13 Contractor after the balancer is complete.
- K DAMPER INTERLOCKS FOR FANS WITH STARTERS:
1. For fan systems with magnetic starters and shutoff dampers specified with end switches, the damper interlock shall be hardwired in such a way that the damper shall open if the fan starter hand / off / auto switch is in the hand or in the auto position and being called to start. After the damper end switch has proven the damper open, a hardwire interlock from the end switch to the starter holding coil for the fan shall cause the fan to start. For fan systems that are ducted in parallel, see specific sequence for fan system on interlock requirements.
- L DAMPER INTERLOCKS FOR FANS WITH VFD'S:
1. For fan systems with VFD's and shutoff dampers specified with end switches, the damper end switches shall be hardwire interlocked to the safety circuit(s) of the VFD to prevent the fan from starting until the damper is proven open. This interlock shall prevent the fan from running in either the VFD or bypass (if provided) mode. For fan systems that are ducted in parallel, see specific sequence for fan system on interlock requirements.
- M SMOKE DAMPER CONTROL:
1. Smoke dampers provided in ducts are required to close by building code in the event their associated smoke detectors are in alarm or if the associated duct smoke detector requires a minimum velocity to operate and the associated fan(s) that supply, return, or exhaust air through them are shutdown.
 2. For software interlocks of smoke dampers to the fan systems, the smoke dampers will be commanded open and closed on fan status.
 3. For fan systems with safety circuit hardwire interlocks and fan fails to start after an appropriate time delay (not longer than five minutes), smoke dampers shall close, the fan shall be latched off, and an alarm sent through the DDC system. A software reset point and a momentary pushbutton located at the temperature control panel for the associated fan system shall be provided to reset the fan system. On fan system start-up, a time delay shall allow the dampers to open before the fan is started.

4. All necessary software and hardware interlocks shall be provided to perform these functions. See individual fan system control sequences for the type of smoke damper interlock to use and more details on how this should be accomplished.
 5. Alarms shall be provided for each smoke damper by the 23 09 23 Contractor. The alarm shall be generated when the smoke damper is not in its commanded position after the appropriate time delay to allow for the smoke damper to actuate fully. Alarms shall be provided regardless if the smoke damper command is from the DDC system or fire alarm system. Binary inputs to the DDC system from the fire alarm system devices commanding the dampers shall be provided for to allow for all required alarming.
- N FAN INTERLOCKING:
1. Provide interlocks between supply and return or exhaust fan systems as scheduled on the plans or called out in individual control sequences. If DDC controlled, interlocks shall be done through DDC start/stop points unless otherwise specified in individual control sequences. If not DDC controlled, interlocks shall be accomplished via hardwire interlocks between fan starters or VFD's.
- O THERMOSTATS AND SENSORS:
1. All devices and equipment including terminal units, specified to be controlled in a control sequence by a thermostat or sensor, shall be provided with a thermostat or sensor, whether or not the device is indicated on the plans. Consult the HVAC design engineer for the thermostat or sensor location.
- P ORIGINAL EQUIPMENT MANUFACTURER (OEM) CONTROLLER DDC INTEGRATION:
1. Provide DDC programming to define all equipment integral input/output points, setpoints, data points, calculations, etc. that are available through the manufacturers communication interface. Consult with the Owner's DDC operations personnel to determine if some of the points should be omitted (for clarity or lack of value). The following equipment shall be integrated into the DDC system:
 - a. Variable Frequency Drives.
 - b. Lighting Control (furnished by Div 26).
 - c. Power Quality Meters (furnished by Div 26).
- Q WEEKLY SCHEDULING:
1. Provide scheduling of DDC terminal units in groups based on occupancy. Work with the Owner to determine how many groups are required and which zones should be included. Individual terminal units shall be able to receive temporary schedules that will override the group schedules. Temporary override buttons at the zone sensor (where specified on point charts) shall override the scheduling to occupied. When groups that consist of more than 20% of terminal units are indexed to occupied, the associated air handling unit shall start if not already running.
- R CALCULATED DATA POINTS:
1. Provide calculated data points for actual dirty pressure drop for all variable volume air handling units with supply flow measurement based on the following equation:
 - a. Actual Dirty Filter $\Delta P = (\text{Measured Supply CFM}/\text{Design CFM})^2 \times \text{Design Dirty Filter } \Delta P$
 2. Provide a calculated data point for outside airflow for all fans that have return and outside air mixing dampers and the points required to allow for the following equation:
 - a. Outside Airflow = Supply CFM x (MAT-RAT)/(OAT-RAT).

3. Where Supply CFM is measured either on variable volume fans or as balanced on constant volume units, MAT is Mixed Air Temperature, RAT is Return Air Temperature, and OAT is Outside Air Temperature. This point is designed as a check for outside air flow stations accuracy and outside air ventilation minimum damper positions. It should be noted that the accuracy of the calculated outside airflow will diminish as outside air temperature approaches return air temperature. It should be used as a check only when the RAT and OAT are greater than 20 °F and the accuracy of the RAT and OAT temperature sensors are assured.

3.02 HOT WATER BOILERS AND HEATING WATER PUMP CONTROL

- A The hot water boilers shall act as the primary source of heat for the building.
- B BAS shall start/stop boilers when the temperature at the supply water sensor located in the secondary heating loop is below set point. Supply water temperature setpoint will be reset based on outdoor air temperature. Initial schedule shall be 100°F when 40°F and above outside, 140°F when 0°F and below outside. Schedule shall be adjustable from the operator workstation.
- C Boiler controllers will be wired to the primary circulating pumps and start/stop those pumps upon a call for heat. Circulating pumps will be constant volume.
- D BAS shall modulate the boilers to maintain secondary loop temperature set point as described above. Boiler supply water temperature setpoint shall be adjusted to match the reset schedule noted above through integrated communication with the boiler controllers. Master boiler controller will be wired to the other boilers in the plant with a twisted pair and utilize those packaged controls to rotate lead/lag status and parallel operation.
- E BAS shall monitor general alarm status at the boiler controller and display the alarm at the operator workstation.

3.03 SECONDARY HEATING LOOP PUMP (HWP-1) AND PUMP (HWP-2) CONTROL:

- A **START/STOP:**
 1. The DDC system shall start the lead pump whenever the outside air temperature is below 50 degree F. The lag pump shall normally remain off. The hot water pump start/stop relays shall utilize normally closed contacts so upon failure of the relay or DDC controller the pump will fail on. Hot water pumps shall be commanded off if all associated AHU's are off and the outside air temperature is above 50 °F.
- B **LEAD / LAG CONTROL:**
 1. Current status switches, either integral to the VFD and/or discreet devices, shall prove lead and lag pump operation. If the lead pump is called to run and the current status switch indicates that the lead pump is not operating for 30 seconds (adj.), an alarm shall be sent to the operator interface and the DDC system shall start the lag pump. Upon sensing the lead pump is operating, the lag pump shall be stopped. The DDC system shall index the lag pump to become the lead pump through weekly scheduling feature of the building automation system.
- C **SPEED CONTROL:**
 1. Install a differential pressure sensor across the supply and return piping at the point in the system with the highest pressure drop as indicated on plans. The DDC system shall control the operating pump VFD to maintain a setpoint as described below.
 2. Constant Differential Pressure Setpoint Control: The operating pump VFD shall be modulated to maintain a constant setpoint of 10 psig (adj.) at the differential pressure sensor. Final setpoint shall be optimized by the Balancing Contractor.

3. Reset Differential Pressure Setpoint Control: The differential pressure setpoint shall be reset using Trim & Respond logic within the range 2 psig to 12 psig. When the pump is off, the setpoint shall be 8 psig. While the pump is proven on, every five minutes, trim the setpoint by 0.4 psig. if there are one or fewer zone pressure requests. If there is more than one zone pressure requests, respond by increasing the setpoint by 0.6 psig.
 4. A zone pressure request is generated when a reheat coil is greater than 95% open until it drops to 80% open. An air handling unit coil shall count as two zone pressure requests. Provide a binary data enable point for each zone to enable/disable the reheat in the trim and respond algorithm. All setpoints, timers, and zone pressure request threshold for the differential pressure reset shall be adjustable. Tune the reset to prevent cyclic instability after the space is occupied. Provide a trend graph to show the relative stability of the differential pressure setpoint. Final maximum setpoint shall be determined by the Balancing Contractor to satisfy the worst case zone at maximum design condition.
- D MINIMUM FLOW BYPASS CONTROL:
1. When demand in the system is low enough that the differential pressure setpoint is exceeded when the variable speed pump is at its minimum speed (30%), BAS shall modulate the minimum flow bypass valve open to maintain the differential pressure setpoint. The bypass valve shall be closed before pump speed is increased beyond minimum.

3.04 TERMINAL UNIT CONTROL – DDC AND ELECTRIC

- A GENERAL:
1. See the valve chart in Section 23 09 13 for requirements for type of valve, signal required, spring return requirements, and fail positions. The valve requirements specified in the Section 23 09 13 valve chart shall supersede what is called out in the terminal unit sequences.
- B DDC CONTROLLED TERMINAL UNIT MASTER COMMAND POINTS:
1. Provide individual master software points for each of the following functions that can be executed from a single command through the DDC system:
 - a. Command all terminal unit heating valves open (i.e. reheat, radiation, fan coil, etc.).
 - b. Command all terminal unit heating valves closed.
 - c. Command all VAV terminals to scheduled minimum flow by floor.
 - d. Command all VAV terminals to scheduled maximum flow by floor.
- C REHEAT COIL CONTROL:
1. Provide a DDC space temperature sensor to control a modulating electronic control heating coil valve to maintain space temperature. When space temperature is below setpoint modulate the heating coil valve open. The reverse shall occur when space temperature is above setpoint. Provide a discharge air temperature sensor for monitoring purposes. The heating coil valve shall be commanded closed whenever the associated AHU is off.
- D CABINET AND UNIT HEATER CONTROL:
1. Provide an electric space thermostat to control the control valve to maintain space temperature. Provide a strap on aquastat mounted on the hot water return line set at 100 °F to control the unit fan when hot water temperature is above setpoint.
- E VAV TERMINAL UNIT WITH REHEAT DDC CONTROL:
1. Provide a DDC space temperature sensor to control, in sequence, a modulating electronic control valve for the hot water reheat coil and actuator for terminal air flow. When space temperature is below setpoint, the air terminal damper shall modulate toward the cooling minimum flow position.

2. After the air terminal damper is at its minimum flow, the hot water valve shall modulate open to maintain space temperature. The reverse shall occur when space temperature is below setpoint. The heating coil valve shall be commanded closed whenever the associated AHU is off. Provide a discharge air temperature sensor for monitoring purposes.
 3. Weekly schedule the unoccupied mode for each zone and group by function to reduce the number of schedules required per Owner needs or as specified in the terminal unit schedules. Provide a dynamically adjustable group assignment point for each terminal unit zone and a point that can be weekly scheduled for each group. Provide a minimum of one group per ten terminal unit zones (all groups do not need to be used).
 4. Each space temperature sensor shall have a manual override button that shall index the space to the occupied mode for a period of two hours (adj.). If an occupancy sensor is specified, it shall index the terminal unit DDC controller to occupied mode for a minimum of 30 minutes (adj.).
 5. Provide separate adjustable minimum and maximum flow setpoints for both heating and cooling modes in the occupied mode and a separate set of setpoints for the unoccupied mode. Flow setpoints shall be set as scheduled on the plans and specifications.
 6. Where occupancy sensors are specified to be interlocked to the terminal unit for signaling occupancy to the terminal unit zone the following shall occur:
 7. When the occupancy sensor signals the zone is unoccupied, the minimum flow setpoint shall be zero CFM (adj.) and the heating and cooling temperature setpoints will be maintained at either the occupied or unoccupied heating and cooling setpoints as defined by the weekly schedule (grouped or individually). When the occupancy sensor signals the zone is occupied, the occupied minimum flow setpoint shall be as scheduled and the occupied heating and cooling temperature setpoints shall be maintained regardless of the weekly schedule.
 8. Provide separate adjustable cooling and heating setpoints for both the occupied and unoccupied modes. When the space temperature is between the heating and cooling setpoints, the heating valve shall be closed and the airflow at heating and cooling minimum flow.
 9. Where CO₂ sensors are specified to be provided for a zone (VAV-21), provide proportional CO₂ reset of the minimum air flow setpoint based on the CO₂ setpoint for the given zone. See the scheduled values on the plans for minimum airflow setpoints and CO₂ setpoints for each respective zone.
 10. Demo Kitchen and Flex Space terminal units VAV-17 and VAV-18 shall index to full open when grease hood exhaust fan EF-4 is proven on. When EF-4 is off VAV-17 shall operate at minimum position and VAV-18 control shall be released to modulate based on the zone sensor.
 11. Reset of the AHU outside air ventilation rate for a given zone shall also be required if scheduled - see AHU Ventilation sequence.
- F RADIATION/FIN TUBE/CONVECTOR TERMINAL DDC CONTROL WITH REHEAT COILS:
1. Modulate electronic control hot water valve in sequence (simultaneously) with reheat coil to maintain space temperature when associated AHU is running. When space temperature is below setpoint modulate the hot water valve open. The reverse shall occur when space temperature is above setpoint. When the associated AHU is off, the radiation valve will be modulated to maintain heating setpoint and the associated reheat valve shall be closed. Lock hot water valve closed whenever outside air is above 50 °F (adj.).

G RADIATION/FIN TUBE/CONVECTOR TERMINAL STANDALONE DDC CONTROL:

1. Provide a DDC space temperature sensor to control a modulating electronic control hot water valve to maintain space temperature. When space temperature is below setpoint, modulate the hot water valve open. The reverse shall occur when space temperature is above setpoint. Lock hot water valve closed off whenever outside air is above 50 °F (adj.).
2. Provide separate adjustable heating setpoints for both the occupied and unoccupied modes.

3.05 VARIABLE VOLUME MIXED AIR HANDLING UNIT CONTROL (AHU-1 AND AHU-2)

A GENERAL:

1. The Air Handling unit is variable air volume, indoor air unit.
2. The Air Handling unit is controlled by direct digital controller (DDC).
3. The Air Handling unit is equipped with the following:
 - a. Supply fan with VFD.
 - b. Outside air airflow measuring stations furnished by Temperature Control Contractor (TCC). (Refer to specification 23 09 13).
 - c. Relief fan with VFD.
 - d. Outside air damper furnished by MFR. (Refer to specification 23 09 13).
 - e. Return air damper furnished by MFR. (Refer to specification 23 09 13).
 - f. Relief air damper furnished by TCC. (Refer to specification 23 09 13).
 - g. Remote air cooled DX cooling unit.
 - h. DX cooling coil.
 - i. Hot water coil for heating. Heating control valve furnished by TCC. (Refer to specification 23 09 13).
 - j. 30% and 60% filter bank.
 - k. Actuators furnished by TCC. (Refer to specification 23 09 13).

B FAN CONTROL:

1. Start/Stop: The DDC system shall start the supply and relief fan via the VFD.
2. Current Status Switch: Provide as described under GENERAL, VFD Motor Run Status, in this Section for both the supply and return fans.
3. Supply Fan Speed Control: The purpose of the supply fan control is to maintain a minimum static pressure in the supply ductwork to ensure proper terminal air box operation. Install a static pressure sensing probe in the main supply duct located at approximately 3/4 of the way down the main supply duct as shown on the plans and pipe to the differential pressure transmitter that shall be located in the unit temperature control panel. The inputs to the differential pressure transmitter shall be the static pressure inside of the duct and the reference input shall sense the actual space served by the air system. The DDC system shall modulate the supply fan VFD to maintain the static pressure setpoint as sensed by the static pressure. If multiple sensing locations are shown, the DDC system shall maintain the static pressure setpoint at the lowest reading sensor. If the static sensors deviate by more than 0.5 in. w.c. (adj.), an alarm shall be sent through the DDC system. Static pressure setpoint shall be as described in the Static Pressure Reset Control below.
4. Static Pressure Reset Control: Static pressure setpoint shall be reset using Trim & Respond logic within the range 0.15 in. w.g. to 1.3 in. w.g. When the fan is off, the setpoint shall be 0.8 in. w.g.

5. While the fan is proven on, every two minutes, trim the setpoint by 0.04 in. w.g. if there are two or fewer zone pressure requests. If there are more than two zone pressure requests, respond by increasing the setpoint by 0.06 in. w.g.
 6. A zone pressure request is generated when a VAV damper is greater than 95% open until it drops to 80% open. Provide a binary data enable point for each zone to enable/disable the zone damper in the trim and respond algorithm. All setpoints, timers, and zone pressure request threshold for the static pressure reset shall be adjustable. Tune the reset to prevent cyclic instability after the space is occupied. Provide a trend graph to show the relative stability of the static pressure setpoint. Final maximum setpoint shall be determined by the Balancing Contractor to satisfy the worst case zone at maximum design condition.
 7. Relief Fan Speed Control: The purpose of the relief fan control is to maintain a slightly positive building pressure. The relief fan VFD shall modulate to maintain a constant CFM offset of *750 cfm AHU-1 and 350 cfm AHU-2* (adj.) from the associated supply fan to account for total exhaust from the area in which it serves while maintaining a slightly positive pressure. A.T.C. shall coordinate with the Balancing Contractor to optimize this setting.
- C VENTILATION AIR CONTROL:
1. Reset Ventilation Air Flow Setpoint by Summing Zone Ventilation Rates (AHU-1): The outside air ventilation rate required at the AHU shall be determined by adding the base ventilation rate of 750 CFM to the sum of the ventilation airflow required by each zone associated with the AHU that has an occupancy sensor and/or CO2 reset ventilation rates scheduled. The base zone ventilation values to be summed shall be based on the scheduled minimum cfm values on the plans and a minimum 25% outside air rate.
 2. Reset Ventilation Air Flow Setpoint by Summing Zone Ventilation Rates and Direct CO2 Control (AHU-2): The outside air ventilation rate required at the AHU shall be determined by adding the base ventilation rate of 300 cfm to the sum of the ventilation airflow required by each zone associated with the AHU that has an occupancy sensor. The base zone ventilation values to be summed shall be based on the scheduled minimum cfm values on the plans and a minimum 25% outside air rate.
 - a. The CO2 sensors shall directly reset the outside air ventilation rate from the base ventilation rate to the maximum outside air ventilation based on the CO2 reset as scheduled on the plans.
 - b. The operation of EF-4 associated with the demo kitchen grease hood shall index VAV-17 and VAV-18 to full open. The ventilation rate minimum shall be overridden to a ventilation rate of 1500 cfm until EF-4 is proven off.
 3. The economizer control must be switched off and the outside air ventilation control switched on below the outside air temperature at which the outside air flow quantity that would be required to maintain the economizer (discharge) air temperature setpoint is less than the required outside air ventilation flow rate. To do this, the outside air temperature at which this will occur must be calculated by determining the percentage of outside air required at the air handling unit's current supply air flow. Once this is determined, the return air temperature can be used along with the outside air ventilation percentage to calculate the outside air temperature at which the economizer control should be terminated, and the minimum ventilation control should be restarted. Use the following formulas to determine the outside air economizer low temperature switchover setpoint:
 - a. $\%OA = \text{Outside Air Ventilation Air Flow Setpoint} / \text{Supply Air Flow}$.

- b. Outside Air Switchover Setpoint = (Discharge Air Setpoint/%OA) - (Return Air Temp/%OA) + Return Air Temp.
- c. Provide bias setpoint of 3 °F (adj.) below the calculated setpoint to prevent cycling of this control sequence and compensate for heat gain due to fan and humidifier. Differential setpoint shall be 2 °F (adj.).

D FILTERS:

1. Install a differential static pressure sensor across each filter bank. Ensure that the static probes do not impede filter removal.
2. For pre-filter bank, provide an alarm to the operator interface when the differential static pressure exceeds **1.0"** W.C. (adj.).

E DISCHARGE AIR TEMPERATURE CONTROL:

1. Install a temperature sensor in the supply duct downstream of the supply fan, all water coils and humidifiers.
2. Discharge Air Temperature Setpoint: Discharge air temperature setpoint shall be 55 °F (adj.).
3. Discharge Air Temperature Control: The heating coil, mixed air dampers, and the cooling coil shall be controlled in sequence to maintain the discharge air setpoint temperature. At no time shall the heating coil be operating when the mixed air dampers are economizing, or the DX cooling system is running. Whenever the discharge air temperature is above the setpoint, the following shall occur in sequence: The heating coil control shall modulate closed as sequenced below.
4. When heating is completely off and the economizer sequence is enabled, the economizer outside air damper, return air damper, and relief damper will be modulated together in sequence to maintain discharge air temperature setpoint. When the outside air economizer damper is completely open, or the economizer sequence is not enabled, the DX cooling unit will modulate to maintain the discharge air temperature setpoint. When the discharge air setpoint is below setpoint the reverse shall occur. DX cooling control shall be locked out below 50 °F (adj.) outside air temperature.

F ECONOMIZER CONTROL:

1. When the economizer sequence is enabled by the switchover sequence below, the outside air economizer damper, return damper, and relief damper will modulate in sequence to provide outside air to be used for free cooling. The dampers will modulate in sequence with the heating and cooling elements as described in the discharge air temperature control sequence above.
2. Dry Bulb Economizer Switchover: The economizer sequence shall be enabled whenever the outside air temperature is below 68 °F (adj.).

G SAFETIES:

1. General: All safeties shall be hard wired to the supply and return fan starters or VFD safety circuits. Starters shall not function in the "Hand" or "Auto" and VFD's shall be disabled if they are indexed to the "Auto" or "Hand" position in either the VFD or bypass modes.
2. Freezestat: Install an electric freezestat (refer to specification Section 23 09 13 for location) to shut down the unit (see Unit Shutdown for additional information) if the temperature downstream of the heating coil drops below 35 °F (adj.). The electric freezestat shall act independently of the DDC system via hardwire interlock and shall override the DDC system control signal to open the heating coil control valve(s). A freezestat trip shall notify the DDC system that shall send an alarm to the operator interface.

3. Supply Fan High Pressure Limit: Install a static pressure probe located in the air handling unit main discharge duct at least six feet or as far as physically possible downstream of the fan and upstream of any dampers and pipe to a differential pressure switch located in the temperature control panel. Wire in series with the safety circuit of the supply and return fan. Differential pressure switch shall be a manual reset type and the DDC system shall monitor the status of the differential pressure switch. Initial setpoint shall be +4.0" W.C. (adj.)
4. Supply Fan Low Pressure Limit: Install a static pressure probe located in the air handling unit immediately downstream of the prefilter and pipe to a differential pressure switch located in the temperature control panel. Wire in series with the safety circuit of the supply and return fans. Differential pressure switch shall be a manual reset type and the DDC system shall monitor the status of the differential pressure switch. Initial setpoint shall be -2.0" W.C. (adj.).
5. Fire Alarm Shutdown: Upon a Fire Alarm System alarm, the fire alarm control module provided by the electrical Contractor at the temperature control panel shall change state of its contacts. This shall cause the unit to be shut down (see Unit Shutdown for additional information) and all fire/smoke and smoke dampers within this system shall close immediately. An auxiliary contact shall be provided to notify the DDC system of a fire alarm shutdown.

H UNIT SHUTDOWN:

1. Whenever the air handling unit is indexed off, the supply and relief fans shall stop. If the relief fan fails off, the supply fan shall be indexed off. On a failure of either the supply or relief fan, an alarm will be sent through the DDC system. Whenever both supply and relief fans are off for any reason the following shall occur:
2. The outside air dampers and relief air dampers shall close, and the return dampers shall open.
3. The DX cooling unit shall shutdown.
4. The heating coil control valve(s) shall remain under control from the mixed air sensor to maintain 55 °F (adj.). Freezestat shall override heating control valve(s) open.
5. All fire/smoke dampers associated with the air handling system shall close.

I UNOCCUPIED CONTROL:

1. General: Occupied/unoccupied schedule shall be set at the DDC operator interface. When indexed to unoccupied the unit shall shutdown. Where provided, index DDC controlled heating terminal units associated with this air handling unit to maintain setback and setup temperature setpoints unless overridden by occupancy sensor or manual pushbutton.
2. Unit Cycling to Maintain Setback/Setup Temperatures: Cycle the air handling unit on to maintain the setback and setup temperature zone setpoints to maintain 58 °F and 86 °F respectively. Reset supply return fan volume offset for return air fan control to zero. Supply fan shall be limited to the maximum return fan airflow. In the heating mode, the outside air and relief air dampers shall close, and the return air damper shall open, and heating discharge temperature control shall function as specified. In the cooling mode, the economizer and cooling discharge temperature control shall be allowed to function as specified. Minimum on runtime timer shall be set for 15 minutes (adj.) and the off timer for 30 minutes (adj.).

J HEATING OPTIMUM START-UP:

1. This cycle shall override the unoccupied cycle. If the system was operating as a result of the unoccupied cycle, the system shall continue to operate. The DDC system shall measure the zone air temperature designated on the plans and the outside air dry bulb temperature to determine the minimum run time to warm the zone(s) to its setpoint.

2. When the computed start time is reached, the DDC system shall start the air handling system and operate with the outside air and relief air dampers closed and the return air damper open. The air handling unit discharge air temperature shall be controlled as specified under Discharge Air Control. If a pneumatic thermostat dual air main is provided, the main shall be indexed to occupied (day) pressure when this mode is started. When the occupied time is reached, the unit shall be switch to occupied control and ventilation air will be provided.

K COOLING OPTIMUM START-UP:

1. This cycle shall override the unoccupied cycle. If the system was operating as a result of the unoccupied cycle, the system shall continue to operate. The DDC system shall measure the zone air temperature designated on the plans and the outside air dry bulb temperature to determine the minimum run time to cool the zone(s) to its setpoint. When the computed start time is reached, the DDC system shall start the air handling system. The air handling unit discharge air temperature shall be controlled as specified under Discharge Air Control with the economizer and DX cooling control active. If a pneumatic thermostat dual air main is provided, the main shall stay indexed to setback (night) pressure when this mode is active. When the occupied time is reached, the unit shall be switch to occupied control and ventilation air will be provided.

3.06 FUNCTIONAL PERFORMANCE TESTING

- A Contractor is responsible for utilizing the functional performance test procedures supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for functional performance test procedures.

END OF SECTION 23 09 93

INTENTIONALLY LEFT BLANK

SECTION 23 21 13 HYDRONIC PIPING

PART 1 GENERAL

1.01 SCOPE

- A This section contains specifications for all HVAC hydronic pipe and pipe fittings for this project. Included are the following topics:
1. PART 1 - GENERAL
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - i. Welder Qualifications.
 2. PART 2 - PRODUCTS
 - a. Heating Hot Water.
 - b. Makeup Water.
 - c. Chemical Treatment.
 - d. Vents and Relief Valves.
 - e. Cooling Coil Condensate.
 - f. Unions and Flanges.
 - g. Gaskets.
 - h. Mechanical Grooved Pipe Connections.
 3. PART 3 - EXECUTION
 - a. Erection.
 - b. Welded Pipe Joints.
 - c. Threaded Pipe Joints.
 - d. Mechanical Grooved Pipe Connections.
 - e. Copper Pipe Joints.
 - f. Water Systems.
 - g. Makeup Water.
 - h. Chemical Treatment.
 - i. Vents and Relief Valves.
 - j. Cooling Coil Condensate.
 - k. Unions and Flanges.
 - l. Gaskets.
 - m. Piping System Leak Tests.
 - n. Hydronic Piping System Flushing.
 - o. Construction Verification Items.

4. APPENDIX

- a. Piping System Leakage Test Report.
- b. Piping System Flushing Report.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
- B Section 23 05 15 - Piping Specialties.
- C Section 23 05 23 - General-Duty Valves for HVAC Piping.
- D Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- E Section 23 07 00 - HVAC Insulation.
- F Section 23 25 00 - HVAC Water Treatment.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ANSI B16.3 Malleable Iron Threaded Fittings.
- B ANSI B16.4 Cast Iron Threaded Fittings.
- C ANSI B16.5 Pipe Flanges and Flanged Fittings.
- D ANSI B16.22 Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
- E ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- F ASTM A74 Cast Iron Soil Pipe and Fittings.
- G ASTM A105 Forgings, Carbon Steel, for Piping Components.
- H ASTM A126 Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
- I ASTM A181 Forgings, Carbon Steel for General Purpose Piping.
- J ASTM A197 Cupola Malleable Iron.
- K ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- L ASTM A380 Practice for Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems.
- M ASTM B75 Seamless Copper Tube.
- N ASTM B88 Seamless Copper Water Tube.

1.05 SHOP DRAWINGS

- A Refer to section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.
- C TYPE F STEEL PIPE:
 - 1. Statement from manufacturer on their letterhead that the pipe furnished meets the ASTM specification contained in this section.
- D TYPE E OR S STEEL PIPE:
 - 1. Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stenciled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.

- E COPPER TUBE:
 - 1. Statement from manufacturer on their letterhead that the pipe furnished meets the ASTM specification contained in this section.
- F POLYPROPYLENE RANDOM (PP-R) PIPE:
 - 1. Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.
- G HIGH DENSITY POLYETHYLENE (HDPE) PIPE
 - 1. Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

1.06 QUALITY ASSURANCE

- A Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.
- B Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.07 DELIVERY, STORAGE, AND HANDLING

- A Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D Storage and protection methods must allow inspection to verify products.

1.08 DESIGN CRITERIA

- A Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.
- B Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.
- C Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- D Where ASTM A53 type F pipe is specified, ASTM A53 grade A type E or S, or ASTM A53 grade B type E or S may be substituted at Contractor's option. Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- E Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

1.09 WELDER QUALIFICATIONS

- A Before any metallic welding is performed, the Contractor shall submit his Standard Welding Procedure Specifications, Procedure Qualification Records and Qualification Test Records for each Welder along with associated continuity records to demonstrate compliance with ASME Section IX, paragraph QW-322.
- B The Contractor shall maintain a complete set of welder qualification documents at the jobsite, including Test Records and Continuity Records for each welder.

- C The Engineer or Owner reserves the right to test the work of any welder employed on the project, at the Contractor's expense. Testing will include a visual examination of the pipe and weld and may include radiography of any suspect welds. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project. Any welds deemed unacceptable will be repaired at the contractor's expense.

PART 2 PRODUCTS

2.01 HEATING HOT WATER

- A 2 inch and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings.
- B 2-1/2 inch and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel grooved fittings.
- C Contractor may use ASTM B88 seamless, type L, hard temper copper tube with ANSI B16.22 wrought copper solder-joint fittings in lieu of steel pipe for all sizes. Mechanically formed tee fittings may be used in lieu of wrought copper solder-joint tee fittings for branch takeoff up to one-half (1/2) the diameter of the main. The use of "ProPress" type fitting or equal is acceptable.
- D Polypropylene Random (PP-R) Pipe and Fittings:
 - 1. Pipe:
 - a. Shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11.
 - b. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
 - c. All pipe shall be made in a three layer extrusion process.
 - d. Domestic hot water and heating piping shall contain a fiber layer (faser) to restrict thermal expansion.
 - e. All pipe shall comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11.
 - f. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
 - 2. Fittings:
 - a. Fittings shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389.
 - b. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
 - c. All fittings shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

2.02 MAKEUP WATER

- A Extend from where left by the Plumbing Contractor with the same materials.

2.03 CHEMICAL TREATMENT

- A Use pipe and pipe fittings as specified for the system to which the chemical treatment piping is connected. Plastic pipe furnished with the chemical treatment materials may also be used if its pressure/temperature rating is acceptable for the service.
- B Contractor may use ASTM D1785 Poly(Vinyl Chloride) (PVC) Plastic pipe with ASTM 2665 Poly(Vinyl Chloride) (PVC) Vent Pipe and Fittings in lieu of Copper tubing.

2.04 VENTS AND RELIEF VALVES

- A Use pipe and pipe fittings as specified for the system to which the relief valve or vent is connected.

2.05 COOLING COIL CONDENSATE

- A ASTM B88, type L hard temper copper tubing with ASTM B145/ANSI B16.23 cast red bronze or ASTM B75/ANSI B16.29 wrought solder-type drainage fittings.

2.06 UNIONS AND FLANGES

- A 2 inch and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use ANSI B16.18 cast copper alloy unions on copper piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.
- B 2-1/2 inch and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2 inch may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

2.07 GASKETS

- A Water and Glycol Systems: Branded, compressed, non-asbestos sheet gaskets.
- B Manufacturers:
 1. Klingersil; C4401: www.kingersil.com.
 2. Garlock;3000: www.garlock.com.
 3. JM Clipper; 978: www.jmclipper.com.
 4. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.08 MECHANICAL GROOVED PIPE CONNECTIONS

- A Manufacturers:
 1. Victaulic: www.victaulic.com.
 2. Anvil Corp: www.anvilcorp.com.
 3. Star Pipe Products, Inc.: www.starpipeproducts.com.
 4. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Either cut-groove or equivalent roll-groove products are acceptable providing the system temperature and pressure requirements are met. Where malleable iron fittings are indicated, they shall conform to ASTM A47. Where forged steel fittings are indicated, they shall conform to ASTM A106, Grade B. Where fabricated steel fittings are indicated, they shall conform to ASTM A53, type F in sizes 3/4 inch through 1-1/2 inch and type E or S, grade B in sizes 2 inch through 20 inch. Do not use fabricated fittings where malleable iron or forged steel fittings are available. Gaskets in all cases shall be EPDM suitable for temperatures to 230 degrees F.
- C The following services may use mechanical grooved pipe connections within the building in mechanical spaces and above accessible ceilings. Mechanical chases are not considered accessible.
 1. Heating Hot Water.
 2. Chilled Water.
- D Mechanical grooved pipe connections shall not be used in heating plants or below grade utility distribution systems.

- E Mechanical grooved pipe connections shall not be used in chilled water piping between the cooling coil and the isolation valve for that cooling coil.
- F Fittings and couplings must be suitable for the temperature and pressure involved. In no case is the final system to have a pressure rating of less than 125 psig at the design temperature of the fluid.
- G Acceptable fittings and couplings are listed below, based on Victaulic. When used on galvanized piping, fittings and couplings shall be galvanized. When used on black steel piping, fittings and couplings shall have an enamel coating.
- H Couplings: Ductile iron standard couplings, Style 77; lightweight couplings, Style 75; and rigid couplings. Reducing couplings are not acceptable.
- I Flanges: Ductile iron Style 741 or 742 except at lug type butterfly valves where standard welding flanges shall be used.
- J Fittings: Ductile iron elbows and tees of the manufacturer's standard line may be used in all sizes except bullhead tees will not be accepted. Fabricated steel fittings may be used in all sizes where fitting wall thickness conforms to standard weight pipe. Mechanical-T Style 920 fittings with malleable iron housings may be used for up to 2 inch outlet size.
- K Mechanical grooved pipe couplings are not allowed as a substitute for expansion compensation specified in Section 23 05 48.
- L Mechanical grooved flexible couplings are not allowed as a substitute for the flexible connectors specified in Section 23 05 48 at pump connections.

PART 3 EXECUTION

3.01 ERECTION

- A Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job site immediately. Excluding minor surface rust, piping that exhibits significant oxidation or corrosion will be rejected.
- B Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.
- C Remove all loose dirt, scale, oil, chips, burrs and other foreign material from the internal and external surfaces of all pipe and piping components prior to assembly, including debris associated with cutting, threading and welding.
- D During fabrication and assembly, remove slag and weld spatter from internal pipe surfaces at all joints by peening, chipping and wire brushing.
- E During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of the system. Use plugs, caps, blind flanges or other items designed for this purpose.
- F Furnish and install all flanges, caps, bypasses, drains, valves, etc. required to facilitate flushing and draining all heating and cooling system piping.
- G Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- H Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.

- I Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.
- J "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.
- K Install drains throughout the systems to permit complete drainage.
- L Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
- M Install all valves, control valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

3.02 WELDED PIPE JOINTS

- A Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.
- B All pipe welding shall be completed by Qualified Welders in accordance with the Contractor's Procedure Specifications.
- C Contractor will ensure that these steps are followed where pipe sections will be joined by welding:
 - 1. Cleaning – Welding surfaces will be clean and free of defects.
 - 2. Alignment – Inside diameter of piping components will be aligned as accurately as possible. Internal misalignment shall not exceed 1/16 inch.
 - 3. Spacing – Pipe sections will be spaced to allow deposition of weld filler material through the entire weld joint thickness.
 - 4. Girth Butt Welds:
 - a. Girth butt welds shall be complete penetration welds.
 - b. Concavity will not exceed 1/32 inch.
 - c. Under cuts will not exceed 1/32 inch.
 - d. As welded surfaces are permitted however surfaces will be free from coarse ripples, grooves, abrupt ridges and valleys.
- D Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

3.03 THREADED PIPE JOINTS

- A Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.04 MECHANICAL GROOVED PIPE CONNECTIONS

- A Use pipe factory grooved in accordance with the coupling manufacturer's specifications or field grooved pipe in accordance with the same specifications using specially designed tools available for the application.
- B Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with the coupling manufacturer's specifications.
- C Support pipe as indicated in Section 23 05 29 of these specifications except as modified below. Support each horizontal pipe section at least once between couplings and whenever a change in direction of line flow takes place. Support vertical pipe at every other floor or every other pipe length, whichever is most frequent. Set the base of the riser or the base fitting on a pedestal or foundation.

- D Follow coupling manufacturer's installation recommendations if they are more stringent than the above requirements.

3.05 COPPER PIPE JOINTS

- A Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux, and assemble joint. Use 95-5 solder or brazing to secure joint as specified for the specific piping service.
- B Where mechanically formed tee fittings are allowed, form mechanically extracted collars in a continuous operation, consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Use an adjustable collaring device. Notch and dimple the branch tube. Braze the joint, applying heat properly so that pipe and tee do not distort; remove distorted connections.

3.06 WATER SYSTEM

- A Run water mains level or pitch horizontal mains up 1 inch in 40 feet in the direction of flow. Install manual air vents at all high points where air may collect. If vent is not in an accessible location, extend air vent piping to the nearest code acceptable drain location with vent valve located at the drain.
- B Main branches and run outs to terminal equipment may be made at the top, top 45 degree, side, and/or bottom 45 degree of the main provided that there are drain valves suitably located for complete system drainage and manual air vents are located at all top and top 45 degree connections. Bottom connections are not acceptable unless approved by the Owner's Mechanical Inspector.
- C Use top or top 45 degree connection to main for up feed risers and bottom 45 degree connection to main for down feed risers. Bottom connections are not acceptable unless approved by the Owner's Mechanical Inspector.
- D Use a minimum of two elbows in each pipe line to a piece of terminal equipment to provide flexibility for expansion and contraction of the piping systems. Offset pipe connections at equipment to allow for service, such as removal of the terminal device.
- E Use eccentric fittings for changes in horizontal pipe sizes with the fittings installed for proper air venting. Concentric fittings may be used for changes in vertical pipe sizes.

3.07 MAKEUP WATER

- A Install where indicated and/or specified, including all valves, piping specialties and dielectric unions required for a functional system.

3.08 CHEMICAL TREATMENT

- A Install chemical treatment piping as indicated on the drawings, as detailed, and as recommended by the supplier of the chemical treatment equipment.

3.09 VENTS AND RELIEF VALVES

- A Install vent and relief valve discharge lines as indicated on the drawings, as detailed, and as specified for each specific valve or piping specialty item. In no event is a termination to occur less than six feet above a roof line.

3.10 COOLING COIL CONDENSATE

- A Trap each cooling coil drain pan connection with a trap seal of sufficient depth to prevent conditioned air from moving through the piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes as detailed.

3.11 UNIONS AND FLANGES

- A Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

3.12 GASKETS

- A Store horizontally in cool, dry location and protect from sunlight, water and chemicals. Inspect flange surfaces for warping, radial scoring or heavy tool marks. Inspect fasteners, nuts and washers for burrs or cracks. Replace defective materials.
- B Align flanges parallel and perpendicular with bolt holes centered without using excessive force. Center gasket in opening. Lubricate fastener threads, nuts and washers with lubricant formulated for application.
- C Draw flanges together evenly to avoid pinching gasket. Tighten fasteners in cross pattern sequence (12 – 6 o'clock, 3 – 9 o'clock, etc.), one pass by hand and four passes by torque wrench at 30% full torque, 60% full torque and two passes at full torque per ASME B16.5.

3.13 PIPING SYSTEM LEAK TESTS

- A Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.
- B Provide all piping, fittings, blind flanges, and equipment to perform the testing.
- C Conduct pressure test with test medium of air or water unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the Owner. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.
- D Do not insulate pipe until it has been successfully tested.
- E For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- F For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.

<u>System</u>	<u>Pressure</u>	<u>Medium</u>	<u>Duration</u>
Heating hot water	100 psig	Water	8 hr

- G All pressure tests are to be documented on a form included in this specification.
- H On piping that cannot be tested because of connection to an active line, provide temporary blind flanges and hydrostatically test new section of piping. After completion of test, remove temporary flanges and make final connections to piping. Die penetrate test pass weld or x-ray the piping that was not hydrostatically tested up to the active system.

3.14 HYDRONIC PIPING SYSTEM FLUSHING

- A All new chilled water and heating hot water system piping shall be flushed thoroughly before the systems are put in to operation.

- B Subsequent to executing the chemical cleaning processes specified in Section 23 25 00 – HVAC Water Treatment, and prior to adding scale and corrosion inhibitors, flush all piping and components with a clean source of water until the discharge from the system is clean. Discharge shall be from drains provided at all low points in the piping, ends of headers and as otherwise necessary to flush and drain the entire system.
- C Project specific procedures shall be established prior to flushing. Before beginning flushing operations, submit proposed flushing procedures to the Engineer and Owner for review and approval. Provide sufficient notice to the Engineer and/or Owner to allow the flushing operations to be observed.
- D A clean water source shall be tapped into the system downstream of the main circulation pump(s). Provide minimum 2 inch connection between water source and hot water/chilled water systems including taps with ball valves (or line size tap and ball valve for piping systems smaller than 2 inch). Provide minimum 2 inch taps (or line size if mains are smaller than 2 inch) at the ends of headers, the low point of each of the mains on each floor and as otherwise necessary to flush and drain the entire system. Provide minimum 2 inch bypass with shut off valve (or line size if mains are smaller than 2 inch) between the supply and return mains on each floor as where directed by the Engineer and Owner or where shown on the drawings. Contractor shall identify proposed clean water source along with the method/location of drain discharge and review with the Engineer and Owner prior to installing flushing connections to water source and drain outlets. Provide code required temporary backflow prevention for the clean water source if needed. Provide all temporary taps, valves, piping, bypasses and hoses as needed to accomplish flushing procedures. The Owner’s chilled water system shall NOT be used as a source of water for flushing any piping.
- E Flush piping systems using the following procedure:
 - 1. Hot water and chilled water systems is as follows:
 - a. Close isolation valves at all coils and wall fin.
 - b. Open the temporary bypasses that connect the ends of supply and return mains.
 - c. Flush mains by turning on flushing water source and sequentially opening drains on mains on each floor until the discharge is clean. This will flush the mains without forcing water/debris into the branches and run out pipes.
 - d. Close isolation valves located downstream of coils/wall fin.
 - e. Open isolation valves located upstream of coils/wall fin.
 - f. Open individual drain valves upstream of coils/wall fin until the discharge is clean. This will flush the supply branch and run out lines between the mains and the coils/wall fin without running water/debris through the TCV or coils/wall fin.
 - g. Close the individual drain valves upstream of coils/wall fin.
 - h. Open drain valves at low points in the return piping mains.
 - i. Open the individual isolation valves located downstream of the coils/wall fin. This will flush the return branch and run out lines located between the coils/wall fin and the mains back into the mains and out the drains on the return mains. The water going through the coil/wall fin should be already clean since this section was flushed previously.
 - j. Repeat steps 1-3 to clean debris from the mains.
- F Isolate all coils while flushing risers and mains. Flush the mains on each floor individually, starting at the top of the building and working down towards the basement level.

- G After risers and mains have been flushed clean, individually open the drain valves in each branch circuit to discharge any debris that may have accumulated in the branch piping.
- H As directed by Owner, the Contractor will be required to open drain valves at selected locations in the system to verify the effectiveness of flushing procedures. If sediment or debris is identified in the system, it will be flushed again and reinspected at no expense to the Owner.
- I After flushing operations are complete, drain and/or blow out any residual water, clean and replace all strainers, and add scale and corrosion inhibitors as specified in Section 23 25 00. Leave flushing connections/valves in place and cap.
- J All flushing procedures shall be documented by completing and submitting the report form included at the end of this Section.
- K INITIAL FILL AND VENT:
 - 1. Fill hydronic systems with appropriate working fluids as specified. All system fluids shall be chemically treated as specified in Section 23 25 00 - HVAC Water Treatment.
- L For closed piping systems, all air trapped at high points shall be relieved through the manual air vents prior to notifying Owner that the systems are ready to be tested and balanced.

3.15 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

END OF SECTION 23 21 13

PIPING SYSTEM LEAKAGE TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____ Project No: _____

Contractor: _____

HVAC Refrigeration Controls

Power Plant Plumbing Sprinkler

Test Medium: Air Water Other _____

Test performed per specification section No. _____

Specified Test Duration _____ Hours Specified Test Pressure _____ PSIG

System Identification: _____

Describe Location: _____

<i>Test Date:</i> _____	
<i>Start Test Time:</i> _____	<i>Initial Pressure:</i> _____ PSIG
<i>Stop Test Time:</i> _____	<i>Final Pressure:</i> _____ PSIG

Tested By: _____

Witnessed By: _____

Title: _____

Title: _____

Signed: _____

Signed: _____

Date: _____

Date: _____

Comments: _____

PIPING SYSTEM FLUSHING REPORT (revised 1/23/07)

Date Submitted: _____

Project Name: _____

Location: _____ Project No: _____

Contractor: _____

System Identification (check one):

Chilled Water

Process Chilled Water

Heat Reclaim

Heating Hot Water

Other _____

Describe procedure: _____

Flush Date: _____ Start Time: _____ Stop Time: _____

Pressure of Water Source: _____ PSIG Describe water source and method of connection to source:

Flushed By: _____ Witnessed By: _____

Title: _____ Title: _____

Company: _____ Company: _____

Signed: _____ Signed: _____

Date: _____ Date: _____

Describe results: _____

INTENTIONALLY LEFT BLANK

SECTION 23 21 23 HYDRONIC PUMPS

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for water pumps used for HVAC applications. Included are the following topics:
1. PART 1 - GENERAL
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Quality Assurance.
 - e. Shop Drawings.
 - f. Operation and Maintenance Data.
 - g. Design Criteria.
 2. PART 2 - PRODUCTS
 - a. In-Line Centrifugal Pumps.
 - b. Variable Speed ECM In-Line Pumps.
 3. PART 3 - EXECUTION
 - a. Installation.
 - b. Variable Speed ECM In-Line Pumps.
 - c. Construction Verification Items.
 - d. Functional Performance Testing.
 - e. Owner Training.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

1.03 REFERENCE

- A Applicable provisions of Division 1 shall govern work under this section.

1.04 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.05 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
B Include data concerning dimensions, capacities, materials of construction, ratings, weights, pump curves with net positive suction head requirements, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.
C Pump curves shall identify design point of operation.

1.06 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.07 DESIGN CRITERIA

- A Pump sizes, capacities, pressures and operating characteristics shall be as scheduled.
B Pumps shall meet or exceed operating efficiencies scheduled.

- C Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard, and other accessories specified. Statically and dynamically balance all rotating parts. Provide flanged connections on all pumps unless specified otherwise. Service or repair of base mounted pumps shall not require breaking piping connections or removal of motor.
- D Where a pump is specified for parallel operation, the scheduled conditions are for that pump with both pumps operating, i.e., total system flow rate is twice that scheduled for a single pump. When only one of the parallel pumps is operating, the operating point of that pump must fall within the manufacturer's recommended operating range.
- E Provide pump with a motor sized for non-overloading over the entire pump curve. Motors to be 1750 rpm unless specified otherwise.
- F Furnish each pump and motor with a nameplate giving the manufacturer's name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current.
- G Test all pumps, clean and paint before shipment. The manufacturer shall certify all pump ratings.
- H All pumps to operate without excessive noise or vibration.
- I After completion of balancing, provide replacement of impellers, or trim impellers to provide specified flow at actual pumping head, as installed.
- J Furnish one spare seal and casing gasket for each pump to Owner.

PART 2 PRODUCTS

2.01 IN-LINE CENTRIFUGAL PUMPS

- A Manufacturers:
 - 1. Bell and Gossett: www.bellgossett.com.
 - 2. Armstrong: www.armstrongpumps.com.
 - 3. Thrush: www.thrushco.com.
 - 4. Taco: www.taco-hvac.com.
 - 5. Grundfos: www.grundfos.com.
 - 6. Aurora: www.aurorapump.com.
 - 7. Wilo USA, LLC: www.wilo-usa.com.
 - 8. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Single stage, direct connected, resiliently mounted motor for in-line mounting, oil lubricated, 175 psig maximum working pressure at operating temperature of 225 ° F continuous, 250 ° F intermittent.
- C Casing:
 - 1. Cast iron or stainless steel; flanged suction and discharge connection; with plugged taps for vent, drain, suction and discharge gauges.
- D Impeller:
 - 1. Brass, bronze or plastic keyed to the shaft, single suction enclosed type, hydraulically and dynamically balanced.
- E Bearings:
 - 1. Two, oil lubricated bronze sleeves or ball bearings capable of being greased.
- F Shaft:
 - 1. Stainless steel or carbon steel with stainless steel or bronze sleeve, integral thrust collar.
- G Seal:
 - 1. Mechanical type, carbon rotating against a stationary ceramic seat, 225 °F maximum continuous operating temperature.

- H Drive:
 - 1. Close coupled.
- I Inter Face Module:
 - 1. 0-10 Volt DC External Input.
 - 2. External Off – potential free closed input terminals.
 - 3. RC Run Circuit remote sensing of pump operation.
 - 4. DP double pump terminals – hook up second (slave) pump.
 - 5. LON interface for LonWorks BMS building automations – FTT 10 A – LONTalk.
 - 6. Data points LON-Protocol:
 - a. Pumps with and without external Sensor:
 - 1) Pump Setpoint.
 - 2) Requested Pump-Operating Mode.
 - 3) Pump Pressure.
 - 4) Pump Flow.
 - 5) Pump Speed.
 - 6) Runtime.
 - 7) Fault States of the Pump.
 - 8) Maintenance States.
 - 9) Fluid Temperature.
 - 10) Power Consumption in Watts.
 - 11) Power Consumption in Kilowatts.
 - 12) Energy Consumption.
 - 13) Control Mode for Normal Operation.
 - b. Pumps with external Sensor additional:
 - 1) Remote Pressure-Sensor Input.
 - 2) Remote Temperature-Sensor Input.
 - 3) Remote Pressure-Sensor Minimum Value.
 - 4) Remote Temperature-Sensor Maximum Value.
 - 5) Remote Temperature-Sensor Minimum Value.
 - 6) Remote Temperature-Sensor Maximum Value.
- J Integrated Variable Frequency Drive (VFD):
 - 1. Fundamental Requirements:
 - a. VFD shall be of the VVC-PWM type providing near unity displacement power factor ($\cos \phi$) without the need for external power factor correction capacitors at all loads and speeds.
 - 2. VFD and Motor Protection:
 - a. VFD and motor protection shall include motor phase to phase fault, motor phase to ground fault, loss of supply phase, over voltage, under voltage, motor over temperature, inverter overload, over current. Over current is not allowed ensuring 4300IVS units will not overload the motor at any point in the operating range of the unit.
 - 3. User Interface:
 - a. VFD shall incorporate an integrated graphical user interface that shall provide running and diagnostic information and identify faults and status in clear English language. Faults shall be logged / recorded for interrogation at a later date.

4. Sensorless Control Algorithm:
 - a. Sensorless control software shall be embedded in the IVS unit to provide automatic speed control in variable volume systems without the need for pump mounted (internal/external) or remotely mounted differential pressure sensor. The default operating mode under Sensorless Control shall be 'quadratic pressure control' whereby head reduction with reducing flow will be according to a quadratic control curve. Control mode setting and minimum / maximum head set-points shall be user adjustable via the inbuilt programming interface.
5. Serial Communications:
 - a. The VFD shall incorporate a USB port for direct connection to a PC and an RS485 connection with Modbus RTU protocol. Optional protocols available should include Lonworks and BACnet
6. Other Control Features:
 - a. The VFD shall have the following additional features:
 - 1) Sensorless override for BMS.
 - 2) Manual pump control or closed loop PID control.
 - 3) Programmable skip frequencies and adjustable switching frequency for noise / vibration control.
 - 4) Auto alarm reset.
 - 5) Motor pre-heat function.
 - 6) Six programmable digital inputs.
 - 7) Two analogue inputs.
 - 8) One programmable analogue / digital output.
 - 9) Two volt-free contacts.

2.02 VARIABLE SPEED ECM IN-LINE PUMPS

- A Manufacturers:
 1. Grundfos: www.grundfos.com.
 2. Wilo USA, LLC: www.wilo-usa.com.
 3. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Display:
 1. Operation status.
 2. Control mode.
 3. Differential pressure or speed/setpoint.
 4. Fault and warning signals.
- C Wet Rotor, Glandless Inline Circulating Pumps:
 1. Electronic variable speed control to operate at constant/variable differential pressure control without external sensors.
 2. Automatic night setback control available as standard using "self-taught, FUZZI" technology.
- D Integrated Synchronous Motors:
 1. ECM technology with permanent magnetic rotors.
 2. Special sensorless control electronics.
 3. Single phase electronic converters.
- E IR (Infra-red) Interface: Wireless communication with the optional infra-red monitor.

- F Integrated Overload Motor Protection:
 - 1. Protect pump against:
 - a. Over/under voltage.
 - b. Over temperature of motor and/or electronics.
 - c. Over current.
 - d. Locked rotor and dry run (no load condition).
- G Fault Contact "FC" Terminals:
 - 1. include in the terminal box, potentially free, normally closed contacts that open in the event of failure.
- H Interface (IF) Modules:
 - 1. Installed in the terminal box.
 - 2. BMS communication via LONworks.
 - 3. 0 – 10 volt DC control of speed or head setpoint.
 - 4. External minimum speed.
 - 5. External off.
 - 6. Dual pump communication and pump operation status.
- I Casing:
 - 1. Cast iron bodies with factory applied Catheporesic coating.
- J Impeller:
 - 1. Constructed of high strength, glass filled polypropylene engineered composite.
- K Motor Bearings:
 - 1. Metal impregnated carbon sleeve bearing type.
- L Shaft:
 - 1. Stainless steel.
- M Seal:
 - 1. Mechanical type, carbon rotating against a stationary ceramic seat, 225 °F maximum continuous operating temperature.
- N Drive:
 - 1. Close coupled.
- O Electrical:
 - 1. Circulating Pump:
 - a. Coded terminal strip indicating common/neutral/ground within the terminal box for field connections for single phase 230 volt, 60 Hz power.
 - 2. Low Voltage Interface (IF) Wiring:
 - a. 18 gauge or larger.
 - b. UL/CSA approved.
 - c. 220 deg F maximum (167 deg F minimum) temperature.
 - 3. 230 Volt Main Power Wiring:
 - a. 14 gauge or larger.
 - b. UL/CSA approved.
 - c. 230 deg F maximum (167 deg F minimum) temperature.
 - 4. Motor: Minimum Class H winding insulation, UL 778.

5. Voltage:
 - a. Variances less than +/- 10% from rated voltage with pump under load conditions.
 - b. Maximum amperage not to be exceeded is indicated on the pump nameplate.
 - c. Electrical power to the pump is confirmed when the face of the graphic display is lit.
- P Inter Face Module:
 1. 0-10 Volt DC External Input.
 2. External Off – potential free closed input terminals.
 3. RC Run Circuit remote sensing of pump operation.
 4. DP double pump terminals – hook up second (slave) pump.
 5. LON interface for LonWorks BMS building automations – FTT 10 A – LONTalk.
 6. Data points LON-Protocol:
 - a. Pumps with and without external Sensor:
 - 1) Pump Setpoint.
 - 2) Requested Pump-Operating Mode.
 - 3) Pump Pressure.
 - 4) Pump Flow.
 - 5) Pump Speed.
 - 6) Runtime.
 - 7) Fault States of the Pump.
 - 8) Maintenance States.
 - 9) Fluid Temperature.
 - 10) Power Consumption in Watts.
 - 11) Power Consumption in Kilowatts.
 - 12) Energy Consumption.
 - 13) Control Mode for Normal Operation.
 - b. Pumps with external Sensor additional:
 - 1) Remote Pressure-Sensor Input.
 - 2) Remote Temperature-Sensor Input.
 - 3) Remote Pressure-Sensor Minimum Value.
 - 4) Remote Temperature-Sensor Maximum Value.
 - 5) Remote Temperature-Sensor Minimum Value.
 - 6) Remote Temperature-Sensor Maximum Value.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install all pumps in strict accordance with manufacturer's instructions. Access/service space around pumps shall not be less than minimum space recommended by pump manufacturer.
- B Support piping adjacent to pump such that no weight is carried on pump casings.
- C Decrease from line size at pump connections with suction diffusers where specified, long radius reducing elbows or concentric reducers/increasers in the vertical piping, and eccentric reducers/increasers for horizontal piping. Install eccentric reducers/increasers with the top of the pipe level.
- D All valves and piping specialties must be full line size as indicated on the drawings.
- E Lubricate pumps before startup.

- F Install a full line size spring loaded check valve and balancing valve in the pump discharge piping. At Contractor's option, combination shut-off, check, balancing valve may be substituted instead of separate valves. Reference Section 23 05 23.

3.02 VARIABLE SPEED ECM IN-LINE PUMPS

- A Installed with the motor shaft in a horizontal plane with no exceptions. The electrical terminal box shall be installed either horizontally with the IR window to the left of the "Red Button" (wiring connections to the right of the terminal box) or vertically with the IR window above the "Red Button" (wiring connections below the terminal box).
- B Installed in a way that it is not stressed by the pipework. A minimum of three pipe diameters is recommended on the inlet of the pump.

3.03 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

3.04 FUNCTIONAL PERFORMANCE TESTING

- A Contractor is responsible for utilizing the functional performance test procedures supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for functional performance test procedures.

3.05 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under specification Section 01 91 01 - Commissioning Process.

END OF SECTION 23 21 23

INTENTIONALLY LEFT BLANK

SECTION 23 23 00 REFRIGERANT PIPING

PART 1 GENERAL

1.01 SCOPE

- A This section contains specifications for all Refrigerant piping for this project. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Refrigerant Piping.
 - b. Refrigerant Piping Accessories.
 3. PART 3 – EXECUTION.
 - a. Preparation.
 - b. Erection.
 - c. Refrigerant Piping.
 - d. Refrigerant Piping Accessories.
 - e. Construction Verification Items.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
C Section 23 07 00 - HVAC Insulation.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ANSI B16.22 Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
B ASTM B88 Seamless Copper Water Tube.
C ASTM B280 Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
D ASHRAE 15 Safety Code for mechanical Refrigeration.

1.05 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
B Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.
C Copper Tube:
 1. Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

1.06 QUALITY ASSURANCE

- A Order all copper refrigeration tube with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier; with soft straight lengths or coils identified with a tag indicating that the product was manufactured in accordance with ASTM B280; and with each hard temper straight length identified throughout its length by a blue colored marking not less than 3/16 inch in height and a legend at intervals of not greater than three feet that includes the designation "ACR" and pipe outside diameter.
- B Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.07 DELIVERY, STORAGE, AND HANDLING

- A Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. If end caps are not present on tube bearing the "ACR" designation, clean and re-cap in accordance with ASTM B280. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D Storage and protection methods must allow inspection to verify products.

1.08 DESIGN CRITERIA

- A Use only new material, free of defects and scale, and meeting the latest revision of ASTM specifications as listed in this specification.
- B Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

PART 2 PRODUCTS

2.01 REFRIGERANT PIPING

- A ASTM B88 type L hard drawn copper tube, cleaned and capped in accordance with ASTM B280, and marked "ACR", with ANSI B16.22 wrought copper or forged brass solder-type fittings.

2.02 REFRIGERANT PIPING ACCESSORIES

- A Provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 450 psig and a maximum working temperature of 225 deg F. For systems using R-410A, provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 850 psig and a maximum working temperature of 225 deg F.
- B Flexible pipe connectors: Double braided bronze hose flexible pipe connectors with solder end connections.
- C Filter Dryers: For circuits 15 tons and over provide angle pattern filter dryers with replaceable core. For circuits below 15 tons provide straight pattern filter dryers without replaceable core.
- D Sight glasses: Two piece brass construction with solder end connections. Include color indicator for sensing moisture.
- E Solenoid Valves: Two way normally closed with two piece brass body, full port, stainless steel plug, stainless steel spring, teflon diaphragm and solder end connections. Provide replaceable coil assembly.
- F Hot Gas Bypass Valves: Provide with integral solenoid valve, external equalizer connection and adjustable pilot assembly.
- G Thermostatic Expansion Valves: Brass body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.

- H Charging Valves: Provide ¼" SAE brass male flare access ports with finger tight, quick seal caps. Provide 2-inch long copper extension sections.
- I Check valves: Spring loaded type with bronze body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.

PART 3 EXECUTION

3.01 PREPARATION

- A Remove all foreign material from interior and exterior of pipe and fittings.

3.02 ERECTION

- A Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- B Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
- C Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

3.03 REFRIGERANT PIPING

- A Refrigeration piping to be installed by firms who are experienced in installation of such piping.
- B All solder joints to be ASTM Grade 4 or 5 and have a melting point of approximately 1250 degrees F. Solder impurities shall not exceed 0.15%. Tubing to be new and delivered to the job site with the original mill end caps in place. Clean and polish all joints before soldering. Avoid prolonged heating and burning during soldering. Purge all lines with nitrogen during soldering. Provide manual shut-off and check valves as required.
- C No refrigerant is to be vented directly to the atmosphere except that which may escape through leaks in the system during leak testing. During evacuation procedures, use equipment designed to recover and allow recycling of the refrigerant.
- D Leak test the system by charging the system to a pressure of 10 psig with an HFC refrigerant, with the compressor suction and discharge valves closed and with all other system valves open. Increase pressure to 300 psig with dry nitrogen. Rap all joints with a mallet and check for leaks with an electric leak detector having a certified sensitivity of at least one ounce per year. Seal any leaks that may be found and retest.
- E After completion of the leak test, evacuate the system with a vacuum pump to an absolute pressure not exceeding 1500 microns while the system ambient temperature is above 60°F. Break the vacuum to 2 psig with the refrigerant to be used in the system. Repeat the evacuation process, again breaking the vacuum with refrigerant. Install a drier of the required size in the liquid line, open the compressor suction and discharge valves, and evacuate to an absolute pressure not exceeding 500 microns. Leave the vacuum pump running for not less than two hours without interruption. Raise the system pressure to 2 psig with refrigerant and remove the vacuum pump.
- F Charge refrigerant directly from original drums through a combination filter-drier. Each drier may be used for a maximum of three cylinders of refrigerant and then must be replaced with a fresh drier. Charge the system by means of a charging fitting in the liquid line. Weigh the refrigerant drum before charging so that an accurate record can be kept of the weight of refrigerant put in the system.

- G If refrigerant is added to the system through the suction side of the compressor, charge in vapor form only.

3.04 REFRIGERANT PIPING ACCESSORIES

- A Install accessories in accordance with the manufacturer's written instructions and recommendations.

3.05 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

END OF SECTION 23 23 00

SECTION 23 25 00 HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for chemical treatment of all water, steam, and condensate systems. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Reference.
 - c. Related Work.
 - d. Quality Assurance.
 - e. Shop Drawings.
 - f. Operation and Maintenance Data.
 - g. Design Criteria.
 - h. Maintenance Service.
 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. System Cleaner.
 - c. System Inhibitor.
 - d. Algaecides.
 - e. Closed Water System Treatment.
 - f. Treatment Equipment.
 - g. Test Equipment.
 3. PART 3 – EXECUTION.
 - a. Preparation.
 - b. Cleaning Sequence.
 - c. Closed Water Systems.
 - d. Test Cabinet.
 4. APPENDIX.
 - a. Pipe Cleaning and Treatment Report.

1.02 REFERENCE

- A Applicable provisions of Division 1 shall govern work under this Section.

1.03 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 15 - Piping Specialties.

1.04 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.05 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
B Required for all equipment and chemicals specified including data concerning dimensions, capacities, materials of construction, weights, operating sequence, composite wiring diagrams and appropriate identification.

- C Chemical data to include the description of the chemical, its composition, its function, and the associated material safety data sheet.

1.06 OPERATION AND MAINTENANCE DATA

- A Provide for the services of the manufacturer's trained representative to approve the installation and instruct the Owner in the operation of each system.
- B Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.07 DESIGN CRITERIA

- A Recommend a periodic test procedure and chemical treatment program for each system.
- B Treat the following systems:
 - 1. Chilled water.
 - 2. Hot water.
 - 3. Reclaim water.
 - 4. Glycol water.
 - 5. Condenser water.
 - 6. Steam boiler water.
 - 7. Steam condensate.
 - 8. Fuel oil.
- C Provide the initial chemical treatment for all systems based on a complete system fluid analysis prior to the equipment installation. The initial chemical treatment supply of chemicals for each system shall be adequate for the start-up and testing period, for the time the systems are being operated by the Contractor for temporary heating and cooling, and for one year after start-up of the system.
- D The chemicals used in the condenser water treatment system shall use only liquid chemicals and shall contain no phosphates or chromates.
- E Provide electrical devices, motors, wiring and conduit in accordance with the applicable sections of the Electrical Specifications.

1.08 MAINTENANCE SERVICE

- A Furnish service and maintenance of treatment systems for one year from date of substantial completion.
- B Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- C Provide laboratory and technical assistance services for the warranty period.
- D Include two 4 hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of the treatment systems. Arrange course at startup of systems.
- E Provide site inspection of equipment during scheduled shutdown to evaluate success of the treatment program. Make recommendations in writing based on these inspections.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Betz Entac.
- B Dearborn Div. - W. R. Grace & Co.: www.grace.com.
- C Fremont Industries: www.fremontind.com.
- D Mitco Water Labs: www.mitcowaterlabs.com.

- E Mogul Corporation: www.mogulwater.com.
- F Nalco Chemical Co.: www.nalco.com.
- G Western Water Management: www.westernwatermanagement.com.
- H Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.02 SYSTEM CLEANER

- A Blend of organic alkaline penetrants, emulsifiers, surfactants and corrosion inhibitors that remove grease and petroleum products from the interior of piping systems. Cleaners that contain trisodium phosphate are specifically not acceptable.

2.03 SYSTEM INHIBITOR

- A Scale and corrosion inhibitor consisting of boron nitrite, benzol thiazol, benzotriazole, mercapto-benzothiazole, and tolyltrizole silicates.

2.04 ALGAECIDES

- A Chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones, all in a liquid format.

2.05 CLOSED WATER SYSTEM TREATMENT

- A Sequestering agent to reduce deposits and adjust pH: polyphosphate.
- B Corrosion inhibitors: boron-nitrite, sodium nitrite and borax, sodium tolyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
- C Conductivity enhancers: phosphates or phosphonates.

2.06 TREATMENT EQUIPMENT

- A Bypass feeder:
 - 1. 5 gallon minimum capacity, 125 psig working pressure, either a screw type cover or a valved funnel opening to feed chemical into the system, prime coat of paint.
- B Solution Metering Pump:
 - 1. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and relief valve.
- C Solution Tanks:
 - 1. 30 gallon capacity, polyethylene, self-supporting, 5 gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch.
- D Agitator:
 - 1. Totally enclosed electric motor, stainless steel clamp, motor mount, and propeller.
- E Liquid Level Switch:
 - 1. Polypropylene housing with integrally mounted polyvinylchloride air trap, receptacles for connection to metering pump, and low level alarm contact.
- F Conductivity Controller:
 - 1. Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit.
- G Solenoid Valves:
 - 1. Forged brass body, globe pattern, normally open or closed as required, general purpose solenoid enclosure unless another type is recommended for the specific application, and continuous duty coil with voltage compatible with the remainder of the system components.

2. Use stainless steel body and trim in lieu of brass if brass is not compatible with valves installed in the lines handling the chemical treatment.

H Timers:

1. Electronic timers, infinitely adjustable over full range of 150 seconds to five minutes, mounted together in cabinet with hand-off-automatic switches and status lights.

I Hand Pump:

1. Rotary hand pump for dispensing fluid from shipping drums, corrosion resistant housing, steel suction pipe, polyethylene or polyvinylchloride discharge pipe, threaded fitting for connection to a 2" bung opening on the drum head. Hand pump to be capable of pumping against a head of [] feet.

2.07 TEST EQUIPMENT

A Provide an enameled test cabinet with local fluorescent light, capable of accommodating a sufficient quantity of 10 milliliter burettes and associated reagents for the tests listed below.

B Provide the following test kits:

1. Alkalinity titration test kit.
2. Chloride titration test kit.
3. Sulphite titration test kit.
4. Total hardness titration test kit.
5. Low phosphate test kit.
6. Conductivity bridge, range 0 to 10,000 microhms.
7. Creosol red pH slide complete with reagent.
8. Portable electronic conductivity meter.
9. High nitrite test kit.

PART 3 EXECUTION

3.01 PREPARATION

A Prior to cleaning, verify that systems are operational, filled, started, and vented. Use water meter to record capacity in each system.

B Place terminal control valves in the full-open position

3.02 CLEANING SEQUENCE

A General:

1. Systems are to be cleaned before they are used for any purpose except conduct pressure test before cleaning. Add cleaner to closed systems at concentrations as recommended by the manufacturer. Remove water filter elements from the system before starting circulation. For steam systems, fill boilers only, using the water and cleaner solution.
2. Use neutralizer agents on recommendation of the system cleaner supplier and approval of the Engineer.
3. Remove, clean, and replace strainer screens.
4. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
5. Use Owner form to document system cleaning, flushing, and proper startup.

B Hot Water Heating Systems:

1. Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water.

2. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Apply heat while circulating, slowly raising temperature to 160°F and maintain for 12 hours minimum; vent all high points to assure 100% system circulation. Remove heat and circulate to 100°F or less; drain system as quickly as possible and refill with clean water. Circulate for 6 hours at design temperature, vent air at all high points, then drain. Refill with clean water and repeat until the system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building heating or cooling.

3.03 CLOSED WATER SYSTEMS

- A Install a separate bypass type feeder at the pumps for each closed hot water heating and system. Provide a separate set of supply and return lines from each pump in the system and install ball valves in each of these lines. Locate the system connection that supplies the feeder upstream of the discharge shutoff valve for the pump. Locate the system connection that returns treatment back to the system at a convenient point downstream of the pump discharge shutoff valve. Provide a drain valve at the bottom of the feeder.

3.04 TEST CABINET

- A Locate test cabinet where indicated on the drawings.

END OF SECTION 23 25 00

PIPE CLEANING AND TREATMENT REPORT

Project Number: _____
Date Submitted: _____
Project Name: _____
Location: _____
Contractor: _____

System Tested: Hot Water___ Glycol Water___ Chilled Water___ Fuel Oil___
Condenser Water___ Steam___ Condensate___

System Volume: _____

Materials Used (Provide MSDS for each)

Cleaner: _____ Quantity Used: _____
Inhibitor: _____ Quantity Used: _____
Sequestering Agent: _____ Quantity Used: _____
Algaecide: _____ Quantity Used: _____
Neutralizer: _____ Quantity Used: _____
Glycol: _____ Quantity Used: _____

Glycol Solution Water Source: _____ Percent Glycol by Volume: _____

M Alkalinity

Prior to Cleaning: _____ During Cleaning: _____ After Flushing: _____

System Temperature: Prior to Cleaning: _____ During Cleaning: _____

Duration	Date/Time	
	Start	Stop
Initial Circulation	_____	_____
Draindown	_____	_____
System Refill	_____	_____
Final Circulation	_____	_____
Heating System Warmup	_____	_____

Component Checklist (Describe procedures performed at each)

Strainers: _____

Filters: _____

Vents: _____

Drains: _____

Traps: _____

Branch Lines: _____

Terminal Units: _____

Boilers: _____

Chillers: _____

Comments: _____

SECTION 23 31 00 HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for all duct systems used on this project. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Design Criteria.
 - h. Delivery, Storage and Handling.
 2. PART 2 – PRODUCTS.
 - a. General.
 - b. Ductwork Pressure Class.
 - c. Materials.
 - d. High Pressure Ductwork (Pressure class 3 inch and over).
 - e. Low Pressure Ductwork (Maximum 2 inch pressure class).
 - f. Kitchen Hood Exhaust Duct Construction.
 - g. Duct Sealant.
 - h. Gaskets.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Ductwork Support.
 - c. Low Pressure Duct (Maximum 2 inch pressure class).
 - d. High Pressure Duct (Pressure class 3 inch and over).
 - e. Kitchen Hood Exhaust Duct Construction.
 - f. Cleaning.
 - g. Leakage Test.
 - h. Structural Test.
 - i. Construction Verification Items.
 4. APPENDIX.
 - a. Duct Leakage Test Report.
 - b. Duct Structural Test Report.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 33 00 - Air Duct Accessories.
C Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

1.03 REFERENCE

A Applicable provisions of Division 1 govern work under this Section.

1.04 REFERENCE STANDARDS

- | | | |
|---|------------------|---|
| A | ANSI SS-EN 485-2 | Aluminum and Aluminum Alloys-Sheet, Strip and Plate-Part 2: Mechanical Properties. |
| B | ASTM B209 | Specification for Aluminum and Aluminum-Alloy Sheet and Plate. |
| C | ASTM A90 | Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles. |
| D | ASTM A167 | Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip. |
| E | ASTM A623 | Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process. |
| F | ASTM A527 | Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality. |
| G | ASTM 924 | Standard Specification for General Requirements for Sheet Steel, Metallic-coated by the Hot-dip Method. |
| H | ASTM C 1071 | Specification for Fibrous Glass Duct Lining Insulation. |
| I | ASTM C 411 | Test Method for Hot Surface Performance of High Temperature Thermal Insulation. |
| J | ASTM E 84 | Test Method for Surface Burning Characteristics of Building Materials. |
| K | ASTM C 1338 | Test Method for Determining Fungal Resistance of Insulation Materials and Facings. |
| L | ASTM G 21 | Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi. |
| M | ASTM C 916 | Standard Specification for Adhesives for Duct Thermal Insulation
NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems. |
| N | UL 181 | Standard for Safety for Factory Made Air Ducts and Air Connectors. |
| O | NAIMA | Fibrous Glass Duct Liner Standard. |

1.05 QUALITY ASSURANCE

A Refer to Section 01 40 00 - Quality Requirements.

1.06 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Include manufacturer's data and/or Contractor data for the following:
1. Fabrication and installation drawings.
 2. Schedule of duct systems including material of construction, gauge, pressure class, system class, method of reinforcement, joint construction, fitting construction, and support methods, all with details as appropriate.
 3. Duct sealant and gasket material.
 4. Duct liner including data on thermal conductivity, air friction correction factor, and limitation on temperature and velocity.

1.07 DESIGN CRITERIA

A Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions.

- B Use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications, unless noted otherwise:
 - 1. HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005.
 - 2. HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012.
 - 3. HVAC Systems - Duct Design, 4th Edition, 2006.
 - 4. Rectangular Industrial Duct Construction Standard, 2nd Edition, 2004.
 - 5. Round Industrial Duct Construction Standards, 2nd Edition, 1999.
 - 6. Thermoplastic Duct (PVC) Construction Manual, 2nd Edition, 1995.
- C Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

1.08 DELIVERY, STORAGE AND HANDLING

- A Promptly inspect shipments to ensure that Ductwork is undamaged and complies with the specification.
- B Protect Ductwork against damage.
- C Protect Ductwork by storing inside or by durable, waterproof, above ground packaging. Do not store material on grade. Protect Ductwork from dirt, dust, construction debris and foreign material. Where end caps/packaging is provided, take precautions so caps/packaging remain in place and free from damage.
- D Offsite storage agreements do not relieve the Contractor from using proper storage techniques.
- E Storage and protection methods must allow inspection to verify products.

PART 2 PRODUCTS

2.01 GENERAL

- A All sheet metal used for construction of duct shall be 24 gauge or heavier except for round and spiral ductwork and spiral duct take-offs 12" and below may be 26 gauge where allowed in SMACNA HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005.
- B Duct sizes indicated on plans are net inside dimensions; where duct liner is specified, dimensions are net, inside of liner.

2.02 DUCTWORK PRESSURE CLASS

- A Minimum acceptable duct pressure class, for all ductwork except transfer ductwork, is 2 inch W.G. positive or negative, depending on the application. Transfer ductwork minimum acceptable duct pressure class is 1 inch W.G. positive or negative, depending on the application. Duct system pressure classes not indicated on the drawings to be as follows:

Supply duct upstream of VAV boxes	_3_ in. pressure class
Supply duct downstream of VAV terminals	_2_ in. pressure class
Transfer ducts	_2_ in. pressure class
Exhaust ducts	_2_ in. pressure class
Return ducts	_2_ in. pressure class
Relief ducts	_2_ in. pressure class

2.03 MATERIALS

- A Galvanized Steel Sheet:
 - 1. Use ASTM A 653 galvanized steel sheet of lock forming quality. Galvanized coating to be 1.25 ounces per square foot, both sides of sheet, G90 in accordance with ASTM A90. Provide "Paint Grip" finish for ductwork that will be painted.

- B Uncoated Black Steel Sheet:
 - 1. First quality, soft steel sheet capable of welding or double seaming without fracture.
- C Aluminum Sheet:
 - 1. Use ANSI/ASTM B209 aluminum sheet, alloy 3003H-14, capable of double seaming without fracture.
- D Stainless Steel Sheet:
 - 1. Use ASTM A167, Type 304 or 316 stainless steel sheet as specified, 316L if welded ductwork, with No. 2B finish for concealed work and No. 3 finish for exposed work.
- E Polyvinylchloride Coated Steel Sheet:
 - 1. Use hot-dipped galvanized steel sheet with prime coat and a polyvinyl chloride film on both sides. Thickness of coating to be a minimum of 4 mils on each side. United Sheet Metal Uni-Coat, made by United McGill Co., may be used at Contractor's option.
 - 2. Where any duct surface is scratched, marred, or otherwise damaged, paint with PVC aerosol spray.
 - 3. All couplings shall be slip-joint construction with a minimum 2 inches insertion length. Seal all couplings with sealants as specified.
- F Prefabricated Grease Ducts:
 - 1. Dual wall construction with stainless steel inner liner, insulation and stainless steel (for exposed locations) or aluminized steel (for concealed locations) shell. Furnish all items which form a part of the assembly, including, tee sections, straight sections, elbows, end caps, cleanouts, expansion joints, fan/hood transitions, supports, flashing, counter flashing, and insulated roof thimble where required. Each section shall bear the factory applied Underwriters Laboratories Label.

2.04 HIGH PRESSURE DUCTWORK (PRESSURE CLASS 3 INCH AND OVER)

- A Manufacturers:
 - 1. Ajax.
 - 2. Semco: www.semcoinc.com.
 - 3. United Sheet Metal: www.unitedsheetmetal.com.
 - 4. Sheet Metal Connectors: www.smcduct.com.
 - 5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Machine formed round and/or flat oval spiral lock seam duct constructed of galvanized steel.
- C Rectangular high pressure duct using a transverse joint system as manufactured by Ductmate, Nexus, TDC, TDF, or approved equal, may be used at Contractor's option. Duct to be flanged, gasketed and sealed.
- D Contractor fabricated ductwork meeting specified construction standards is acceptable with prior approval of Engineer. Submit construction details, a description of materials to be used, type of service, reinforcing methods, and sealing procedures.
- E Use a perforated inner liner on double wall high-pressure duct. Annular space between inner liner and outer duct to be filled with 1 inch glass fiber insulation.
- F Use cemented slip joints with 2 inch minimum overlap, flanged connections, or welded/brazed connections, unless noted otherwise for special applications. Prime coat welded joints.
- G Provide standard 90 degree conical tee takeoffs except for exhaust at velocities over 2000 feet per minute, use 45° lateral connections; straight taps or bullhead tees are not acceptable.
- H Internal bracing will not be accepted on ductwork below 48 inches.
- I Use turning vanes as specified in Section 23 33 00.
- J Provide bellmouth fittings or expanded fittings at each duct connection to air plenums.

- K Provide pressure relief fittings as indicated on the plans and/or details.
- L Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.

2.05 LOW PRESSURE DUCTWORK (MAXIMUM 2 INCH PRESSURE CLASS)

- A Fabricate and install ductwork in sizes indicated on the drawings and in accordance with SMACNA recommendations, except as modified below.
- B Construct so that all interior surfaces are smooth. Use slip and drive or flanged and bolted construction when fabricating rectangular ductwork. Use spiral lock seam construction when fabricating round spiral ductwork. Sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if the screw does not extend more than 1/2 inch into the duct.
- C Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits. When a shorter radius must be used due to limited space, install single wall sheet metal splitter vanes in accordance with SMACNA publications, Type RE 3. Where space will not allow and the C value of the radius elbow, as given in SMACNA publications, exceeds 0.31, use rectangular elbows with turning vanes as specified in Section 23 33 00. Square throat-radius heel elbows will not be acceptable. Straight taps or bullhead tees are not acceptable.
- D Where rectangular elbows are used, provide turning vanes in accordance with Section 23 33 00.
- E Provide expanded take-offs or 45 degree entry fittings for branch duct connections with branch ductwork airflow velocities greater than 700 fpm. Square edge 90-degree take-off fittings or straight taps will not be accepted.
- F Button punch snaplock construction will not be accepted on aluminum ductwork.
- G Round ducts may be substituted for rectangular ducts if sized in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission of the Engineer.
- H Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

2.06 KITCHEN HOOD EXHAUST DUCT CONSTRUCTION

- A In concealed locations use minimum 16 gauge black steel or minimum 18 gauge stainless steel with all joints welded liquid tight or prefabricated grease duct, Underwriters Laboratory, Inc listed with aluminized steel shell
- B In exposed areas, use 18 gauge or heavier stainless steel with a number 3 finish and with all joints welded liquid tight or prefabricated Underwriters Laboratory, Inc listed duct with stainless steel shell. Grind and polish all welded joints and seams to a number 3 finish.
- C Provide expanded take-offs for branch duct connections or 45 degree entry fittings. Square edge 90 degree take-off fittings or straight taps will not be accepted.
- D Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits shall be used wherever possible. Shorter radius elbows may be used in areas with limited space with prior approval of the Engineer.
- E No turning vanes may be used in kitchen exhaust duct.
- F Supporting steel and hangers shall not be lighter than the duct gauge.

2.07 DUCT SEALANT

- A Manufacturer:
 1. 3M 800: www.3m.com.
 2. 3M 540 Polyurethane Sealant: www.3m.com.
 3. H.B. Fuller/Foster: www.hbfuller.com.

4. Hardcast: www.hardcast.com.
 5. Hardcast Peel & Seal: www.hardcast.com.
 6. Lockformer cold sealant: www.lockformer.com.
 7. Mon-Eco Industries: www.mon-ecoindustries.com.
 8. United Sheet Metal: www.unitedsheetmetal.com.
 9. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Silicone sealants are not allowed in any type of ductwork installation.
- C Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations. Allow sealant to fully cure before pressure testing of ductwork, or before startup of air handling systems.

2.08 GASKETS

- A 2 inch pressure class and lower:
1. Soft neoprene or butyl gaskets in combination with duct sealant for flanged joints.
- B 3 inch pressure class and higher:
1. Butyl gaskets.

PART 3 EXECUTION

3.01 INSTALLATION

- A Verify dimensions at the site, making field measurements and drawings necessary for fabrication and erection. Check plans showing work of other trades and consult with Architect in the event of any interference.
- B Make allowances for beams, pipes or other obstructions in building construction and for work of other Contractors. Transform, divide or offset ducts as required, in accordance with SMACNA HVAC Duct Construction Standards, Figure 4-7, except do not reduce duct to less than six inches in any dimension and do not exceed an 8:1 aspect ratio. Where it is necessary to take pipes or similar obstructions through ducts, construct easement as indicated in SMACNA HVAC Duct Construction Standards, Figure 4-8, Fig. E. In all cases, seal to prevent air leakage. Pipes or similar obstructions may not pass through high pressure or fume exhaust ductwork.
- C Test openings for test and balance work will be provided under Section 23 05 93.
- D Provide frames constructed of angles or channels for coils, filters, dampers or other devices installed in duct systems, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets and screws or nut, bolts and washers.
- E Install duct to pitch toward outside air intakes and drain to outside of building. Solder or seal seams to form watertight joints.
- F Where two different metal ducts meet, the joint shall be installed in such a manner that metal ducts do not contact each other by using proper seal or compound.
- G Install all motor operated dampers and connect to or install all equipment furnished by others. Blank off all unused portions of louvers, as indicated on the drawings, with 1-1/2 inch board insulation with galvanized sheet metal backing on both sides.
- H Do not install ductwork through dedicated electrical rooms or spaces unless the ductwork is serving this room or space.
- I Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- J Provide adequate access to ductwork for cleaning purposes.
- K Provide temporary capping of ductwork openings to prevent entry of dirt, dust and foreign material.

- L Protect diffusers, registers and grilles with plastic wrap or some other approved form of protection to maintain dirt and dust free and to prevent entry of dirt, dust and foreign material into the ductwork.
- M Install prefabricated grease ductwork assemblies in accordance with manufacturer requirements and NFPA 96.
- N During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.02 DUCTWORK SUPPORT

- A Support ductwork in accordance with SMACNA HVAC Duct Construction Standards, Figure 5-5, except supporting ductwork with secure wire method is not allowed.
- B Support with 3/32 inch, 7 x 7, stainless steel air-craft cable, with matching fastener rated for 50% of actual load, will be allowed on round ductwork under 12 inches if installed as detailed, with cable double looped on duct and at point of support.

3.03 LOW PRESSURE DUCT (MAXIMUM 2 INCH PRESSURE CLASS)

- A Seal all duct, with the exception of transfer ducts, in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.
- B Install a manual balancing damper in each branch duct and for each diffuser or grille. The use of splitter dampers, extractors, or grille face dampers will not be accepted for balancing dampers.
- C Hangers must be wrapped around bottom edge of duct and securely fastened to duct with sheet metal screws or pop rivets. Trapeze hangers may be used at Contractor's option.

3.04 HIGH PRESSURE DUCT (PRESSURE CLASS 3 INCH AND OVER)

- A Seal all duct in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.

3.05 KITCHEN HOOD EXHAUST DUCT CONSTRUCTION

- A Where welded joints are used with black steel duct, coat all external welded joints and seams with paint. Grind and polish to #3 finish all exposed stainless steel joints and seams.
- B Apply bracing and reinforcement to the outside of the duct to prevent breathing, rattling, vibration or sagging of duct.
- C Install without forming dips, sag or traps which might collect residue by supporting at not greater than 5 foot intervals; fasteners at hangers shall not penetrate the duct. Do not use sheet metal screws on supports; use bolted, riveted or welded connections. Where ductwork is listed, install in accordance with listing.
- D Construct grease tight access doors of the same material and thickness as the duct and as large as possible, up to 24 inches in any dimension. Locate on duct sides for ease of inspection and cleaning at each change in direction, not less than every 10 lineal feet of duct, including risers, and not less than 1-1/2 inches from the bottom of the duct.
- E Insulation or fire protection enclosure shall be removable at each access door and clean out.
- F Pitch horizontal ducts back to hood at 1 inch per foot.

3.06 CLEANING

- A Remove all dirt and foreign matter from the entire duct system and clean diffusers, registers, grilles and the inside of air-handling units before operating fans.
- B Clean duct systems with high power vacuum machines where systems have been used for temporary heat, air-conditioning, or ventilation purposes during construction. Protect equipment that may be harmed by excessive dirt with filters, or bypass during cleaning.

3.07 LEAKAGE TEST

- A Test all ductwork in accordance with test methods described in Section 5 of SMACNA HVAC Air Duct Leakage Test Manual. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class.
- B If excessive air leakage is found locate leaks, repair the duct in the area of the leak, seal the duct, and retest.
- C Leakage rate shall not exceed more than 5% of the system air quantity for low pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.
- D Leakage rate shall not exceed more that 1% of the system air quantity for high pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.
- E Leakage test for ductwork downstream of air terminal devices may be omitted but will not relieve the Contractor from duct sealing requirements.
- F Submit a signed report to the Owner's Construction Representative, indicating test apparatus used, results of the leakage test, and any remedial work required to bring duct systems into compliance with specified leakage rates.

3.08 STRUCTURAL TEST

- A Random test all ductwork per Owner direction. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class.
- B Deflection limits shall not exceed those listed in accordance with Chapter 11 of SMACNA HVAC Duct Construction Standards, 3.0 Performance Requirements.
- C Submit a signed report to the Owner's Construction Representative, indicating test apparatus used, results of the structural test, and any remedial work required.

3.09 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

END OF SECTION 23 31 00

DUCT LEAKAGE TEST REPORT

Project Number: _____	
Date Submitted: _____	
Project	Name: _____
	Location: _____
	Contractor: _____
System	Fan No: _____ Leakage Class (C_L): _____
Data	Fan Design CFM: _____ Duct Pressure Class (P_C): _____
	Test Pressure (P_T): _____
Test Equipment	
	Manufacturer: _____ Model No: _____ Serial No: _____

For large systems, use the reverse side for a simple sketch of the entire duct system. Then use letter designations to indicate the various duct sections being tested at one time. Also use the reverse side for test comments.
Note that due to normal construction sequencing it is usually necessary to test risers separately prior to enclosing chases.

Design Data					Field Test Data							
Duct Section	Duct Shape	Duct Surface (Ft ²)	Allowable Leakage		Diameter		Pressure (in. wc.)		Date	Performed By	Observed By	Actual CFM
			Leakage Factor (P ^{0.65} C _L)	CFM for Section	Tube (D ₁)	Orifice (D ₂)	In Duct (P)	Across Orifice (P _{drop})				
TOTAL												

DUCT STRUCTURAL TEST REPORT

Project Number: _____			
Date Submitted: _____			
Project		Name: _____	
		Location: _____	
		Contractor: _____	
System Data		Fan No: _____	
Description of Test Method: _____			

Test Equipment		Manufacturer: _____	Model _____
		No: _____	Serial No: _____

For large systems, use the reverse side for a simple sketch of the entire duct system. Then use letter designations to indicate the various duct sections being tested at one time. Also use the reverse side for test comments.

Note that due to normal construction sequencing it is usually necessary to test risers separately prior to enclosing chases.

Design Data							Field Test Data							
Duct Test Location	Ductwork Shape		Duct Pressure Class	Allowable Ductwork Wall Deflection		Allowable Joint/ Reinforcement Deflection		Pressure (in. wc.) In Duct	Measured Ductwork Wall Deflection		Measured Joint/ Reinforcement Deflection		Per- formed By/ Date	Wit- nessed By/ Date
	H	W		H	W	H	W		H	W	H	W		

SECTION 23 33 00 AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SCOPE

- A This section includes accessories used in the installation of duct systems. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operation and Maintenance Data.
 2. PART 2 – PRODUCTS.
 - a. Manual Volume Dampers.
 - b. Turning Vanes.
 - c. Smoke Dampers and Combination Fire/Smoke Dampers.
 - d. Control Dampers.
 - e. Smoke Detectors.
 - f. Access Doors.
 - g. Flexible Duct.
 - h. Flashings.
 - i. Duct Flexible Connections.
 - j. Hoods for Intake and Exhaust.
 - k. Air Flow Stations.
 3. PART 3 – EXECUTION.
 - a. Manual Volume Dampers.
 - b. Turning Vanes.
 - c. Smoke Dampers and Combination Fire/Smoke Dampers.
 - d. Control Dampers.
 - e. Smoke Detectors.
 - f. Access Doors.
 - g. Flexible Duct.
 - h. Flashings.
 - i. Duct Flexible Connections.
 - j. Hoods for Intake and Exhaust.
 - k. Air Flow Stations.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 29 - Hanger and Supports for HVAC Piping and Equipment.
C Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

D Section 23 31 00 - HVAC Ducts and Casings.

1.03 REFERENCE

A Applicable provisions of Division 1 govern work under this Section.

1.04 REFERENCE STANDARDS

- A NFPA 90A Standard for Installation of Air Conditioning and Ventilating Systems.
- B SMACNA HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, 2005.
- C UL 214 Standard for Factory-Made Air Ducts and Air Connectors.
- D UL 555 (6th edition) Standard for Fire Dampers and Ceiling Dampers.
- E UL 555S (4th edition) Leakage Rated Dampers for Use in Smoke Control Systems.
- F ACMA 610-10 Certified Ratings Program – Product Rating Manual for Airflow Measurement Stations.

1.05 QUALITY ASSURANCE

A Refer to Section 01 40 00 - Quality Requirements.

1.06 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Submit for all accessories and include dimensions, capacities, ratings, installation instructions, and appropriate identification.
- C Include certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance of sound attenuators.
- D Submit manufacturer's color charts where finish color is specified to be selected by the Engineer.

1.07 OPERATION AND MAINTENANCE DATA

A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

PART 2 PRODUCTS

2.01 MANUAL VOLUME DAMPERS

- A Manufacturers:
 - 1. Ruskin: www.ruskin.com.
 - 2. Vent Products: www.ventproducts.com.
 - 3. Air Balance: www.airbalance.com.
 - 4. Pottorff: www.pottorff.com.
 - 5. United Enertech: www.unitedenertech.com.
 - 6. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Dampers must be constructed in accordance with SMACNA Fig. 7-4, Fig. 7-5, and notes relating to these figures, except as modified below.
- C Reinforce all blades to prevent vibration, flutter, or other noise. Construct dampers in multiple sections with mullions where width is over 48 inches. Use rivets or tack welds to secure individual components; sheet metal screws will not be accepted. Provide operators with locking devices and damper position indicators for each damper; use an elevated platform on insulated ducts. Provide end bearings or bushings for all volume damper rods penetrating ductwork constructed to a 3" w.c. pressure class or above.

2.02 TURNING VANES

- A Manufacturers:
 - 1. Aero Dyne: www.aero-dyne.net.
 - 2. Anemostat: www.anemostat.com.

3. Barber-Colman: www.barber-colman.com.
 4. Hart & Cooley: www.hartandcooley.com.
 5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Construct turning vanes and runners for square elbows in accordance with SMACNA Fig. 4-2 and Fig. 4-3 except use only airfoil type vanes. Construct turning vanes for short radius elbows and elbows where one dimension changes in the turn in accordance with SMACNA Fig. 4-4 and Fig. 4-9.

2.03 SMOKE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

- A Manufacturers:
1. Ruskin: www.ruskin.com.
 2. Johnson Controls: www.johnsoncontrols.com.
 3. Air Balance: www.airbalance.com.
 4. Advanced Air: www.advancedair.net.
 5. American Warming and Ventilating: www.awv.com.
 6. Greenheck: www.greenheck.com.
 7. Safe-Air: www.safe-air-corp.com.
 8. Phillips-Aire: www.drillspot.com.
 9. Prefco: www.prefco-hvac.com.
 10. Pottorff: www.pottorff.com.
 11. United Enertech: www.unitedenertech.com.
 12. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Smoke damper assemblies to be UL 555S (4th edition) listed and labeled, and leakage rated at no higher than Class II under UL 555S (4th edition). Unless ratings are indicated elsewhere, dampers should be rated for minimum 2,000 fpm air velocity and 4" static pressure.
- C Combination fire/smoke damper assemblies to be UL 555 (6th edition) and UL 555S (4th edition) listed and labeled and have a fire rating compatible with the rating of the building assembly in which the damper is used, and be leakage rated at no higher than Class II under UL 555S.
- D Provide factory installed electrically operated dampers with linkage arranged so that the damper is closed on loss of power. For electric actuation, provide electric operated dampers with linkage and UL listed operators arranged so that the damper is closed on a loss of power. Where electric actuation is controlled by the DDC system use 0-10 VDC inputs, with stall protection, and with and zero and span adjustments for modulating or 24 VAC for two-position control. All electric actuators will be provided with overload protection to prevent motor from damage when stall condition is encountered. Locate all operators out of the air stream unless large damper size will not allow. Provide form "C" end switches to indicate damper position.

2.04 CONTROL DAMPERS

- A Control dampers are specified in section 23 09 13.

2.05 SMOKE DETECTORS

- A Smoke detectors are furnished and installed by the Electrical Contractor.

2.06 ACCESS DOORS

- A Access door to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock. Hinges shall be steel full length continuous piano type. Doors in concealed spaces may be secured in place with cam sash latches. For both hinged and non-hinged doors provide sufficient number of cam sash latches to provide air tight seal when door is closed.

- B Do not use hinged doors in concealed spaces if this will restrict access. Use minimum 1" deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames. For non-galvanized ductwork, use minimum 1" deep double wall access door with frame that shall use materials of construction identical to adjacent ductwork. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted.
- C Use insulated 1-1/2 hour UL 1978 listed and labeled access doors in kitchen exhaust ducts.

2.07 FLEXIBLE DUCT

- A Manufacturers:
 - 1. Anco Products: www.ancoproductsinc.com.
 - 2. Clevaflex: www.clevaflex.com.
 - 3. Thermafex: www.thermafex.net.
 - 4. Flexmaster: www.flexmasterusa.com.
 - 5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Factory fabricated , UL 181 listed as a class 1 duct, and having a flame spread of 25 or less and smoke developed rating of 50 or under in accordance with NFPA 90A.
- C Suitable for pressures and temperatures involved but not less than a 180°F service temperature and ±2 inch pressure class, depending on the application.
- D Duct to be composed of polyester film, aluminum laminate or woven and coated fiberglass fabric bonded permanently to corrosion resistant coated steel wire helix. Two-ply, laminated, and corrugated aluminum construction may also be used.
- E Where duct is specified to be insulated, provide a minimum 1 inch fiberglass insulation blanket with maximum thermal conductance of 0.23 K (75 degrees F.) and vapor barrier jacket of polyethylene or metalized reinforced film laminate. Maximum perm rating of vapor barrier jacket to be 0.1 perm.

2.08 FLASHINGS

- A Provide flashing to completely weatherproof connection of ductwork to louvers. Flashing to be constructed of material similar to louver material.
- B Flashing and counter flashing for roof curbs will be provided by others.
- C Flashing and curbs for duct and pipe penetrations of roof assemblies to be in accordance with details.

2.09 DUCT FLEXIBLE CONNECTIONS

- A Material to be fire retardant, be UL 214 listed, and meet the requirements of NFPA 90A.
- B Connections to be a minimum of 3 inches wide, crimped into metal edging strip, and air tight. Connections to have adequate flexibility and width to allow for thermal expansion/contraction, vibration of connected equipment, and other movement.
- C Use coated glass fiber fabric for all applications. Material for inside applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with neoprene, air and water tight, suitable for temperatures between -10°F and 200°F and have a nominal weight of 30 ounces per square yard. Material used for outdoor applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with Hypalon, air and water tight, suitable for temperatures between -10°F and 250°F and have a nominal weight of 26 ounces per square yard.
- D For corrosive environments or fume exhaust applications indoors or outdoors, use a material coated with Teflon that is air and water tight, suitable for temperatures between -20°F and 500°F, and has a nominal weight of 14 ounces per square yard.

2.10 HOODS FOR INTAKE AND EXHAUST

- A Manufacturers:
 - 1. Acme: www.acmefan.com.
 - 2. Ammerman.
 - 3. Carnes: www.carnes.com.
 - 4. Cook: www.lorencook.com.
 - 5. Greenheck: www.greenheck.com.
 - 6. Louvers and Dampers: wwwlouvers-dampers.com.
 - 7. Penn: www.pennstateind.com.
 - 8. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Use low silhouette type hoods.
- C Construct hoods of aluminum.
- D Provide bird screen and motor operated damper for each hood.

2.11 AIR FLOW STATIONS

- A Air flow stations are specified in section 23 09 13.

PART 3 EXECUTION

3.01 MANUAL VOLUME DAMPERS

- A Install manual volume dampers in each branch duct and for each grille, register, or diffuser as far away from the outlet as possible while still maintaining accessibility to the damper. Install so there is no flutter or vibration of the damper blade(s).

3.02 TURNING VANES

- A Install turning vanes in all rectangular, mitered elbows in accordance with SMACNA standards and/or manufacturer's recommendations.
- B Install double wall, airfoil, 2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity less than 2000 fpm. Install double wall, airfoil, 4-1/2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity 2000 fpm or greater.
- C If duct size changes in a mitered elbow, use single wall type vanes with a trailing edge extension. If duct size changes in a radius elbow or if short radius elbows must be used, install sheet metal turning vanes in accordance with SMACNA Figure 2-5 and Figure 2-6.

3.03 SMOKE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

- A Install smoke dampers in locations indicated on the drawings in accordance with the manufacturer's instructions. Install an access door adjacent to each damper for inspection and cleaning. Coordinate damper linkage with operators so the dampers are closed when the air system is not operating.
- B Install combination fire/smoke dampers as specified above for fire dampers. Coordinate damper linkage with operators so the dampers are closed when the air system is not operating.

3.04 CONTROL DAMPERS

- A Install dampers in locations indicated on the drawings, as detailed, and according to the manufacturer's instructions. Install blank-off plates or transitions where required for proper mixing of airstreams in mixing plenums. Provide adequate operating clearance and access to the operator. Install an access door adjacent to each control damper for inspection and maintenance.

3.05 SMOKE DETECTORS

- A Installation and wiring of detectors will be by the Electrical Contractor. Install an access door at each detector location.

3.06 ACCESS DOORS

- A Install access doors where specified, indicated on the drawings, and in locations where maintenance, service, cleaning or inspection is required. Examples include, but are not limited to motorized dampers, fire and smoke dampers, smoke detectors, fan bearings, heating and cooling coils, filters, valves, and control devices needing periodic maintenance.
- B Size and numbers of duct access doors to be sufficient to perform the intended service. Minimum access door size shall be 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, or other size as indicated. Install access doors on both inlet and outlet sides of reheat coils as well as other duct mounted coils.

3.07 FLEXIBLE DUCT

- A Flexible duct may only be used for final connections of air inlets and outlets at diffuser, register, and grille locations. Where flexible duct is used, it shall be the minimum length required to make the final connections, but no greater than 5 feet in length, and have no more than one (1) 90 degree bend.
- B Secure inner jacket of flexible duct in place with stainless steel metal band clamp. Secure insulation vapor barrier jacket in place with steel or nylon draw band. Sheet metal screws and/or duct tape will not be accepted.
- C Flexible duct used to compensate for misalignment of main duct or branch duct will not be accepted.
- D Individual sections of flexible ductwork shall be of one piece construction. Splicing of short sections will not be accepted.
- E Flexible ductwork used as transfer duct shall be sized for a maximum velocity of 300 fpm.
- F Penetration of any partition, wall, or floor with flexible duct will not be accepted.

3.08 FLASHINGS

- A Flashing for roof curbs, equipment supports or rails located on roof will be installed by others.

3.09 DUCT FLEXIBLE CONNECTIONS

- A Install at all duct connections to rotating or vibrating equipment, including air handling units (unless unit is internally isolated), fans, or other motorized equipment in accordance with SMACNA Figure 2-19. Install thrust restraints to prevent excess strain on duct flexible connections at fan inlets and outlets; see Related Work.
- B For applications in corrosive environments or fume exhaust systems, use a double layer of the Teflon coated fabric when making the connector.

3.10 HOODS FOR INTAKE AND EXHAUST

- A Install in locations indicated on the drawings, coordinating the roof opening location with the General Contractor. Curbs are covered in Section 23 05 29.

3.11 AIR FLOW STATIONS

- A Install where indicated on the drawings and/or as scheduled and in accordance with manufacturer's recommendations.

END OF SECTION 23 33 00

SECTION 23 34 00 HVAC FANS

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for fans that are not an integral part of a manufactured device. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operation and Maintenance Data.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. General.
 - b. Centrifugal Fans.
 - c. Power Roof Exhaust Fans.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Construction Verification Items.
 - c. Functional performance Testing.
 - d. Owner Training.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
C Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
D Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this Section.

1.04 REFERENCE STANDARDS

- A AMCA 203 - AMCA Fan Application Manual – Troubleshooting.
B AMCA 210 - Laboratory Method of Testing Fans for Rating.
C AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
D NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
E NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
F UL 762 - Power Roof Ventilators For Restaurant Exhaust Appliances.

1.05 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.06 SHOP DRAWINGS

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

- B Include dimensions, capacities, fan curves, materials of construction, ratings, weights, motors and drives, sound power levels, appropriate identification and vibration isolation for all equipment. Sound power levels to be based on tests performed in accordance with AMCA Standard 300.
- C Submit color selection charts for equipment where applicable.
- D Fan curves shall indicate the relationship of CFM to static or total pressure for various fan speeds. Brake horsepower, recommended selection range, and limits of operation are to also be indicated on the curves. Indicate operating point on the fan curves at design air quantity and indicate the manufacturer's recommended drive loss factor for the specific application. Tabular fan performance data is not acceptable.
- E For variable air volume application, include data which indicates the effect of capacity control devices, such as inlet vanes, on performance.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.08 DESIGN CRITERIA

- A Tested and certify all fans in accordance with the applicable AMCA test code.
- B Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. The motor furnished with the fan shall not operate into the motor service factor when operating under these conditions.
- C Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.
- D Where inlet and outlet ductwork at any fan is changed from that shown on the drawings, provide any motor, drive and/or wiring changes required due to increased static pressure or baffling necessary to prevent uneven airflow or improve mixing.
- E All internal insulation and other components exposed to the airstream are to meet the flame spread and smoke ratings contained in NFPA 90A.
- F All roof mounted equipment to be provided with curbs or equipment stands in accordance with specification in Section 23 05 29.

PART 2 PRODUCTS

2.01 GENERAL

- A Use fan size, class, type, arrangement, and capacity as scheduled.
- B Furnish complete with motors, wheels, drive assemblies, bearings, vibration isolation devices, and accessories required for specified performance and proper operation. All single phase motors to have inherent thermal overload protection.
- C Provide variable pitch sheaves for drives 3 hp and smaller, fixed pitch sheaves for drives 5 hp and larger. Design all drives for 150% of motor rating.
- D Use OSHA approved belt guards that totally enclose the entire drive. Construct guards of expanded metal to allow for ventilation; provide tachometer openings at shaft locations.
- E Statically and dynamically balance all fans so they operate without objectionable noise or vibration.
- F Use AMCA Type A spark resistant construction for all fans handling flammable or explosive vapors.
- G All fans handling grease laden vapors shall meet the requirements of UL 762 and NFPA 96.
- H Provide a corrosion resistant coating on all surfaces exposed to fume and other corrosive exhaust air. Coating to be as scheduled.

2.02 CENTRIFUGAL FANS

- A Manufacturers:
1. PennBarry: www.pennbarry.com.
 2. Peerless: www.peerlessblowers.com.
 3. Buffalo: www.buffalofan.com.
 4. Carrier: www.carrier.com.
 5. Champion: www.champion-hvac.com.
 6. Chicago Blower: www.chicagoblower.com.
 7. Greenheck: www.greenheck.com.
 8. New York Blower: www.newyorkblower.com.
 9. Trane: www.trane.com.
 10. Twin City: www.tcf.com.
 11. Cook: www.lorencook.com.
 12. Aerovent: www.aerovent.com.
 13. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Construct housing of welded steel with angle iron frame. Use spun or die formed inlet cones to provide a streamlined flow into the wheel. Use airfoil blades welded to spun wheel cones unless otherwise indicated. Shafts shall be AISI C 1045 hot rolled steel turned ground and polished. Shaft shall be sized for at least 125% of the fans maximum cataloged RPM.
- C Bearings to be self-aligning grease packed pillow block type with grease seal and external grease fittings with a minimum L50 life of 200,000 hours at the maximum cataloged operating speed. Provide each fan housing with a capped drain connection and bolted and gasketed access door for inspection of fan wheel. Unless a special coating is scheduled, paint fans with a prime coat after metal cleaning and surface preparation; apply a second coat of paint to all exterior surfaces.
- D Fans shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.
- E Provide one inch galvanized mesh inlet screens for fans without inlet ductwork.

2.03 POWER ROOF EXHAUST FANS

- A Manufacturers:
1. Carnes: www.carnes.com.
 2. Greenheck: www.greenheck.com.
 3. Penn: www.pennstateind.com.
 4. Jenn-Air: www.jennair.com.
 5. Cook: www.lorencook.com.
 6. ACME: www.acmefan.com.
 7. Aerovent: www.aerovent.com.
 8. Twin City Fan: www.tcf.com.
 9. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Provide upblast or downblast units, as scheduled, with aluminum housing, non-overloading type centrifugal wheel, inlet cone, factory mounted and wired motor and disconnect switch, and bird screen.
- C Electrical Contractor will provide disconnect switches and thermal overload protection for units with three phase motors.

- D Upblast units to have motor, bearings, and drives completely enclosed and isolated from the exhaust air stream with ventilation provided by outside air. Units handling grease laden vapors to be U.L. listed for conveying such vapors, operating continuously at 300 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install as detailed, and according to manufacturer's installation instructions. On units provided with a drain connection, reduce drain connection down to 1/2 inch fitting and leave open.
- B Install thrust restraints in accordance with the requirements of Section 23 05 48.
- C Contractor shall balance blade assembly of destratification fans after installation to assure stable operation.

3.02 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

3.03 FUNCTIONAL PERFORMANCE TESTING

- A Contractor is responsible for utilizing the functional performance test procedures supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for functional performance test procedures.

3.04 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under specification Section 01 91 01 - Commissioning Process.

END OF SECTION 23 34 00

SECTION 23 36 00 AIR TERMINAL UNITS

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for air terminal equipment. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operation and Maintenance Data.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Supply Air Terminal Boxes.
 - b. Terminal Air Box Valve Controls.
 - c. Access Doors.
 - d. Insulation.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Adjusting.
 - c. Construction Verification Items.
 - d. Functional Performance Testing.
 - e. Owner Training.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 09 13 - Instrumentation and Control Devices for HVAC.
C Section 23 09 93 - Sequence of Operation for HVAC Controls.
D Section 23 31 00 - HVAC Ducts and Casings.
E Section 23 33 00 - Air Duct Accessories.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A NFPA 90A Installation of Air Conditioning and Ventilation Systems.
B UL 181 Factory-Made Air Ducts and Connectors.
C ARI-ADC Standard 880.
D ASTM E84 Surface Burning Characteristics of Building Materials.
E UL 723 Surface Burning Characteristics of Building Materials.

1.05 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.06 SHOP DRAWINGS

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

- B Contractor shall submit air terminal unit data including materials of construction, dimensions, scheduled flow rates, pressure drops, radiated and discharge sound power levels, reset volume controller data, actuator spring range and torque data.
- C Contractor shall submit chilled beam operating weights and dimensions of all unit assemblies.
- D Contractor shall submit chilled beam performance data, including sensible and latent cooling capacities, nozzle types, primary and total supply (primary plus induced) airflow rates, chilled (and where applicable hot) water flow rates, noise levels in octave bands, air and water side pressure losses and maximum discharge air throw values.
- E Contractor shall submit chilled beam construction details including manufacturer recommendations for installation, mounting and connection.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.08 DESIGN CRITERIA

- A Select sizes, capacities, configuration, and operating characteristics as shown on the plans and/or as scheduled.

PART 2 PRODUCTS

2.01 SUPPLY AIR TERMINAL BOXES

- A Units shall be single duct and pressure independent.
- B Manufacturers:
 - 1. Carnes: www.carnes.com.
 - 2. Envirotec: www.enviro-tec.com.
 - 3. Metal-Aire: www.metalaire.com.
 - 4. Titus: www.titus-hvac.com.
 - 5. Trane: www.trane.com.
 - 6. Price: www.price-hvac.com.
 - 7. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- C Construction:
 - 1. Unit casing shall be minimum 22 gauge steel and internally insulated with 13/16" rigid fiberglass insulation with a foil scrim face or 3/4 inch thick polyolefin closed cell insulation. Construction to meet UL 181 and NFPA 90A. Casing shall be sealed to limit leakage to a maximum of 15 cfm at 6.0 inches of static pressure. Casing outlet shall have slip and drive joint for connection to discharge ductwork.
 - 2. Metal damper blade shall be mounted to shaft having self-lubricated bearings. Shaft end shall be marked to indicate damper position and shall have a built-in stop to prevent overstroking. Damper blade shall close off against gasket to limit leakage to 10 cfm at 6.0 inches of differential static pressure. Damper linkage shall be sized to accept at least 40 inch-pounds of torque to the damper shaft. Damper shaft shall be provided with a marking indicating damper position.
 - 3. Round inlet collar shall be equipped with a multi-point flow sensor that shall amplify the measured velocity pressure. Pneumatic tubing from flow sensor to differential pressure transducer shall be UL listed, fire retardant (FR) type.
- D Hot Water Reheat Coil:
 - 1. Reference Section 23 82 00 for hot water reheat coil specifications.

2.02 TERMINAL AIR BOX/VENTURI AIR VALVE CONTROLS

A DDC Controls:

1. Damper actuator and differential pressure sensor for flow measurement shall be provided under Section 23 09 14.

B Pneumatic Controls:

1. Actuator shall be furnished with a spring range meeting requirements of the sequence of operation specified in section 23 09 93. The damper actuator shall be arranged so on loss of supply air pressure the damper shall fail open.
2. Factory furnished pneumatic reset controller shall have a five psi reset span regardless of cfm adjustments. Air consumption of the controller shall not exceed 1.0 scfh at 20 psi. Controller shall be field selectable for direct/reverse acting operation and maximum/ minimum cfm setpoints. Controller shall have taps for high and low pressure inputs from flow sensor, 20 psi main air, thermostat input, branch output to damper actuator and gauge taps for calibration of unit.

2.03 ACCESS DOORS

A Standard Access Doors:

1. Access door to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock. Hinges shall be steel full length continuous piano type. Doors in concealed spaces may be secured in place with cam sash latches. For both hinged and non-hinged doors provide sufficient number of cam sash latches to provide air tight seal when door is closed. Do not use hinged doors in concealed spaces if this will restrict access. Use minimum 1" deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames. For non-galvanized ductwork, use minimum 1" deep double wall access door with frame that shall use materials of construction identical to adjacent ductwork. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted.

B Round Duct Access Doors:

1. For duct pressure class positive or negative up to 6 in. wg. Access doors shall be constructed from 16 gauge stainless steel for fume exhaust ducts and 16 gauge galvanized steel for general exhaust or return ducts. Hinges shall be continuous piano style constructed from the same material as the access door. Access doors shall be sealed with 1/4 inch closed cell butyl gasketing permanently bonded on all four sides and no fewer than two draw latches with strike plates. The strike plates shall match the duct/access door material.
2. For duct pressure class positive or negative up to 10 in. wg. Access doors shall be the sandwich type and constructed from two layers of stamped 22 gauge stainless steel for fume exhaust ducts and 22 gauge galvanized steel for general or return ducts. Access doors shall be sealed with 1/4 inch butyl gasketing permanently bonded to all four sides of the inside door. The bolts and springs shall be constructed from the same material as the access door. The knobs shall be constructed from polypropylene with threaded metal inserts and able to be fastened without the use of wrenches.

2.04 INSULATION

A Materials or accessories containing asbestos will not be accepted.

B Use composite insulation systems (insulation, jackets, sealants, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less.

- C The following two internal insulation options may be utilized.
- D Rigid Fiberglass Insulation:
 - 1. Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 degrees F.
 - 2. Foil-scrim-kraft vapor barrier jacket, factory applied to insulation, maximum permeance of .02 perms. All exposed insulation edges shall be covered with metal nosing.
- E Polyolefin Insulation:
 - 1. Flexible closed cell, minimum nominal density of 1.5 lbs. per cu. ft., thermal conductivity of not more than 0.24 at 75 degrees F, minimum compressive strength of 5 psi at 25% deformation, maximum water vapor permeability of 0.0 perm inch, maximum water absorption of 0% by weight and volume, rated for service range of -165 degrees F to 210 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

- A Air Terminals:
 - 1. Install air terminal units as indicated on project drawings and in accordance with the manufacturer's installation instructions.
 - 2. Mount air terminal boxes with a minimum 3 feet of straight ductwork upstream of inlet flow sensor for sizes 12" diameter and below. Provide a minimum of 3X the inlet diameter of straight duct upstream of the inlet flow sensor for inlet sizes above 12" diameter.
 - 3. Where hot water reheat coils are provided with air terminal boxes the following two options may be used.
 - 4. Field mount coil separate from box with a 12-18" section of duct between the air terminal box and reheat coil. The reheat coil and 12-18" section of duct shall be wrapped with external insulation as indicated in specification Section 23 07 00 - HVAC Insulation.
 - 5. Factory mount coil in extended supply air terminal unit. The supply air terminal unit shall be extended at the factory 12-18" and internally insulated to match the insulation used for the supply air terminal unit.
 - 6. Provide at least 24" of clearance on controller side of the air terminal unit. The clearance area shall extend the full length of the supply air terminal unit and the full length (including the access door) of the exhaust/return air terminal unit
 - 7. Support air terminal units from building structure using sheet metal straps or trapeze hanger with rods. Do not mount air terminal units off of adjacent ductwork or piping.
 - 8. Access Doors:
 - a. Duct Access Doors – Square Duct:
 - 1) Provide duct access doors in duct or extended supply air terminal unit upstream and downstream of the reheat coil. Duct access doors shall be as large as duct allows with a maximum size of 18"x18". Install heating coils in accordance with Section 23 73 12 - Air Handling Unit Coils.
 - b. Duct Access Doors – Round Duct:
 - 1) Install round duct access doors on the side of the duct upstream of the return/exhaust terminal unit. At no time shall the access door be installed in the bottom of the duct. Piano hinged style access doors shall be installed with the piano hinges located 1/2 above the bottom of the duct to allow the access door to swing down toward the floor.

B Insulation:

1. Rigid Fiberglass Insulation:
 - a. All rigid duct insulation edges shall be covered with metal nosing. Foil scrim face must completely separate the rigid fiberglass duct material from the air stream.
2. Polyolefin Insulation:
 - a. Apply full cover coat of adhesive to surface to be insulated, insulation and edge butt joints. Place insulation with edge joints firmly butted pressing to surface for full adhesion. Seal seams and joints vapor tight.
 - b. For supply air terminal units, provide five feet of 1 inch thick lining immediately downstream from air terminal unit discharge. Where hot water reheat coils are field or factory installed, provide five feet of 1 inch thick lining in ductwork immediately downstream of reheat coil. Refer to specification section 23 33 00 – Air Duct Accessories for liner specification.

3.02 ADJUSTING

- A Coordinate adjustment of air terminal units with Section 23 05 93 - Testing, Adjusting and Balancing.

3.03 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

3.04 FUNCTIONAL PERFORMANCE TESTING

- A Contractor is responsible for utilizing the functional performance test procedures supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for functional performance test procedures.

3.05 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under specification Section 01 91 01 - Commissioning Process.

END OF SECTION 23 36 00

INTENTIONALLY LEFT BLANK

SECTION 23 37 13 DIFFUSERS, REGISTERS AND GRILLES

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for air terminal equipment. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Submittals.
 - g. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Square Ceiling Diffusers - High Performance.
 - c. Plenum Slot Diffusers – with Gasketed Blade.
 - d. Side-Wall Registers and Grilles.
 - e. Eggcrate Grille.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Construction Verification Items.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
C Section 23 31 00 - HVAC Ducts and Casings.
D Section 23 33 00 - Air Duct Accessories.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
B UL 181 - Factory-Made Air Ducts and Connectors.
C ARI-ADC Standard 880.

1.05 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.06 SUBMITTALS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
B Furnish submittal information including, but not limited to, the following:
 1. Manufacturer's name and model number.
 2. Identification as referenced in the documents.
 3. Capacities/ratings.
 4. Materials of construction.
 5. Sound ratings.

6. Dimensions.
7. Finish.
8. Color selection charts where applicable.
9. Manufacturer's installation instructions.
10. All other appropriate data.

1.07 DESIGN CRITERIA

- A All performance data shall be based on tests conducted in accordance with Air Diffusion Council (ADC) Test Code 1062 GRD 84.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Carnes: www.carnes.com.
- B Krueger: www.krueger-hvac.com.
- C Titus: www.titus-hvac.com.
- D Metal-Aire: www.metalaire.com.
- E E.H. Price: www.price-hvac.com.
- F United Sheet Metal: www.unitedsheetmetalinc.com.
- G Tuttle & Bailey: www.tuttleandbailey.com.
- H Raymon Donco: www.raymon-hvac.com.
- I Substitutions: Refer to Section 01 60 00 - Product Requirements.
- J Acceptable manufacturers for specific products are listed under each item.

2.02 SQUARE CEILING DIFFUSERS - HIGH PERFORMANCE

- A Diffusers to be aluminum (Steel) unless otherwise indicated, louvered face furnished with frame type appropriate to installation.
- B Diffuser shall have throw characteristics of a round diffuser having a 360 degree horizontal blow pattern.
- C Louver cones shall be one-piece construction with no corner joints.
- D White, baked enamel finish or powder coat finish, unless otherwise indicated.
- E High performance type diffuser incorporating short throws and low NC levels.
- F Manufacturers:
1. Titus; Model TMS: www.titus-hvac.com.
 2. Carne; Series SF: www.carnes.com.
 3. Price; Model SCD: www.price-hvac.com.
 4. Metal Aire; Series 5800: www.metalaire.com.
 5. Krueger; Series 1400: www.krueger-hvac.com.
 6. Tuttle & Bailey: www.tuttleandbailey.com.
 7. Raymon Donco: www.raymon-hvac.com.
 8. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.03 PLENUM SLOT DIFFUSER - WITH GASKETED BLADE

- A Steel, furnished with T-bars compatible with ceiling components. Extruded aluminum pattern with a gasket on top edge to form a seal against the plenum wall or slot divider. Pattern control field adjustable from vertical to horizontal discharge.
- B Provide 24 gauge galvanized steel (uninsulated) insulated plenum. Provide round or oval inlet collar designed to fit standard flexible duct sizes.
- C Double metal thickness slot face.

D White, baked enamel finish or powder coat finish, unless otherwise indicated. Flat black diffuser vanes and frame interior.

E Manufacturers:

1. Titus; Model TBD-80: www.titus-hvac.com.
2. Carnes; Model DA: www.carnes.com.
3. Price; Model TBD4: www.price-hvac.com.
4. Metal Aire; Series PHP: www.metalaire.com.
5. Krueger; Series PTBS: www.krueger-hvac.com.
6. Raymon-Donco; Series BA/BS: www.raymon-hvac.com.
7. Tuttle & Bailey: www.tuttleandbailey.com.
8. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.04 SIDE-WALL REGISTERS AND GRILLES

A Aluminum (Steel) unless otherwise indicated, with frame type appropriate to installation.

B Double deflection type blade supply registers and supply grilles allow deflection adjustment in all direction.

C Opposed blade volume control damper supply registers, operable from face.

D Fixed blade (0 degree, 45 degree) core return and exhaust registers and grilles.

E Opposed blade volume control damper return registers, operable from face.

F Register and grille sizes as shown on drawings and/or as scheduled.

G White, baked enamel finish or powder coat finish, unless otherwise indicated.

H Screw holes on surface counter sunk to accept recessed type screws.

I Manufacturers:

1. Titus; Series 300 (supply) and series 350 (return/exhaust): www.titus-hvac.com.
2. Carnes; Model R series: www.carnes.com.
3. Price; Model 520 (Supply) Or 530 (return/exhaust): www.price-hvac.com.
4. Metal Aire; Series V4000 or H4000: www.metalaire.com.
5. Krueger; Series 880: www.krueger-hvac.com.
6. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.05 EGGRATE GRILLE

A Aluminum construction with frame type appropriate to installation.

B Grille face 1/2" x 1/2" or 1" x 1" grid pattern 1" deep with a minimum of 85% free area.

C Grille sizes and finishes as shown on drawings and/or as scheduled.

D White, baked enamel finish or powder coat finish, unless otherwise indicated.

E Screw holes on surface counter sunk to accept recessed type screws.

F Manufacturers:

1. Titus; Model 50: www.titus-hvac.com.
2. Carnes; Model RAE or RAT: www.carnes.com.
3. Price; Model 80: www.price-hvac.com.
4. Metal Aire; Model CC: www.metalaire.com.
5. Krueger; Model EGC: www.krueger-hvac.com.
6. Tuttle & Bailey: www.tuttleandbailey.com.
7. Raymon Donco: www.raymon-hvac.com.
8. Substitutions: Refer to Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.
- B Furnish diffusers with equalizing grids where it is not possible to maintain minimum 2 duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.
- C Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar size.
- D Seal connections between ductwork drops and diffusers/grilles airtight.
- E Blank off unused portion of linear slot diffusers and linear bar diffusers and grilles.
- F Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.
- G In clean rooms and animal holding rooms, caulk space between diffuser or grille and ceiling or wall to be air and watertight. User clear, non-hardening silicone sealant compatible with ceiling or wall surfaces. Sealant shall be resistant to microbiological growth.

3.02 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

END OF SECTION 23 37 13

SECTION 23 41 00 PARTICULATE AIR FILTRATION

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for air system filters. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operation and Maintenance Data.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. MERV 8 Filters.
 - c. Housings for MERV 8 Filters.
 - d. Filter Gauges.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Filter Gauges.
 - c. Construction Verification Items.
 - d. Owner Training.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 07 00 - HVAC Insulation.
C Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ASHRAE Standard 52.
B UL 181 – Standard for Factory-Made Air Ducts and Air Connectors.
C UL 586 – Standard for High Efficiency Particulate Air Filter Units.
D UL 900 – Standard for Air Filter Units.

1.05 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.06 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
B Include data concerning dimensions, materials, efficiencies, installation instructions and appropriate identification.
C Provide the follow-up paragraph or similar when the use of tested media is required. Test reports should be included in the shop drawings.

D Independent test reports verifying filter performance, test procedures and ratings.

1.07 OPERATION AND MAINTENANCE DATA

A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.08 DESIGN CRITERIA

- A Use UL Class 1 or Class 2 filters unless noted otherwise. (Reference applicable UL standard referenced).
- B Efficiencies indicated in this section are based on ASHRAE Standard 52.
- C Fan motors have been selected to operate against the resistance of dirty filters as specified in this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A American Air Filter: www.americanairfilter.com.
- B Barnebey-Cheney: www.genemco.com.
- C Cambridge: www.cambridgefilterusa.com.
- D Camfil: www.camfil.com.
- E Continental: www.continental-filters.co.za.
- F Flanders: www.flanderscorp.com.
- G Mine Safety Appliances: www.msanet.com.
- H Research Products: www.research-products.com
- I Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.02 MERV 8 FILTERS

- A Use 2" thick, pleated panels, 100% synthetic, self-supported media fully bonded and sealed in cardboard frame.
- B Media nominal rating to be 500 FPM face velocity, 0.20 inch WG initial resistance, 1.0 inches WG recommended final resistance., Average arrestance of filter media shall be 90-92%
- C Furnish a side access housing or holding frame as scheduled.
- D Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

2.03 HOUSINGS FOR MERV 8 FILTERS

- A Housing or holding frame to be of the same manufacturer as filter media or provided by the air handling unit manufacturer. Contractor fabricated housings or filter racks will not be accepted. Casing and tracks constructed of galvanized or enameled steel or aluminum. Provide access to the media tracks from outside the casing so media and be readily changed. Filter tracks shall be constructed to provide a minimum clearance of 2 inches between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

2.04 FILTER GAUGES

- A Manufacturers:
 - 1. Dwyer: www.dwyer-inst.com.
 - 2. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Direct reading, 3-1/2 inch dial type, diaphragm actuated, in a metal case. Lettering shall be black figures on white background. Provide front recalibration adjustment.

- C Provide gauges with the following ranges:

<u>Filter Type</u>	<u>Scale Range (inch W.G.)</u>
MERV 8	0.0 to 1.0

- D Provide one gauge for each filter bank, suitable for flush or surface mounting. Include an air filter gauge accessory package consisting of mounting bracket, aluminum tubing, two static pressure tips, and vent valves for each gauge.

PART 3 EXECUTION

3.01 INSTALLATION

- A Where air handling equipment is to be used for temporary heating or ventilation of a facility, do not operate the equipment until specified filter media has been installed. Contractor shall be responsible for maintaining the cleanliness of air handling apparatus and air distribution systems during construction through regular inspection and changing of filter media throughout the construction period.
- B Where air handling apparatus is used during the construction period, install new filter media prior to start of air balancing. Additionally, deliver one new set of media to the Owner prior to substantial completion.
- C Install units as shown on drawings and details according to manufacturer's instructions.
- D Reinforce filter holding frames per manufacturer's instructions.
- E Maintain necessary clearance for changing filters.

3.02 FILTER GAUGES

- A Install filter gauge static pressure tips upstream and downstream of filters. Mount gauge on outside of filter housing or filter plenum in accessible position outside of the unit housing, (***The intent is to have the gauge viewable without opening an access door***); install tubing and gauge valves between gauge and sensor tips. Adjust and level each gauge.

3.03 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

3.04 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under specification Section 01 91 01 - Commissioning Process.

END OF SECTION 23 41 00

INTENTIONALLY LEFT BLANK

SECTION 23 52 00 HEATING BOILERS

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for hot water and steam heating equipment. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Energy Efficiency.
 - g. Submittals.
 - h. Operation and Maintenance Data.
 - i. Registration.
 - j. Warranty.
 2. PART 2 – PRODUCTS.
 - a. Condensing Boilers Greater than 399 MBH.
 3. PART 3 – EXECUTION.
 - a. Examination.
 - b. Installation.
 - c. Boilers.
 - d. Connections.
 - e. Field Quality Control.
 - f. Construction Verification Items.
 - g. Functional Performance Testing.
 - h. Owner Training.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 23 - General Duty Valves for HVAC Piping.
C Section 23 21 13 - Hydronic Piping.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ASME CSD-1 Control and Safety Devices for Automatically Fired Boilers.
B ASME Boiler and Pressure Vessel Code I - Rules of Construction of Power Boilers.
C ASME Boiler and Pressure Vessel Code VIII - Rules for Construction of Pressure Vessels.
D ASME Boiler and Pressure Vessel Code IX - Welding and Brazing Qualifications.
E ASME Boiler and Pressure Vessel Code I V - Rules for Construction of Heating Boilers.
F UL 296 Oil Burners.
G UL 795 Commercial Industrial Gas Heating Equipment.

H NFPA 70 Electrical wiring and devices.

I National Electric Code.

1.05 QUALITY ASSURANCE

A Refer to Section 01 40 00 - Quality Requirements.

1.06 ENERGY EFFICIENCY

A All boilers with a capacity of less than 300,000 btu/hr. input must be labeled as Energy Star by its manufacturer.

B All boilers with a capacity of 300,000 btu/hr. input must meet the efficiencies specified. Minimum boiler efficiencies are based on Federal Energy Management Program (FEMP) recommendations.

1.07 SUBMITTALS

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

B Include data concerning dimensions, capacities, and material of construction, ratings, weights, manufacturer's installation requirements and performance limitations.

C Submit manufacturer's installation instructions including required clearance to combustible materials.

1.08 OPERATION AND MAINTENANCE DATA

A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.09 REGISTRATION

A Complete Boiler and Unfired Pressure Vessel (UPV) Installation Registration and forward to the Department of Commerce.

1.10 WARRANTY

A Sealed combustion boiler, condensing, hi-efficiency, (modular,) helical heat exchanger/combustion chamber design that will be self-supporting and warranted for a period of (10) years to withstand thermal shock. Heat exchanger shall be warranted against leakage for a period of (10) years.

PART 2 PRODUCTS

2.01 CONDENSING BOILERS GREATER THAN 399 MBH

A Manufacturers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide AERCO International or a comparable product by one of the following:
 - a. AERCO International.
 - b. Buderus.
 - c. Viessmann Manufacturing Co. (US) Inc.
 - d. Substitutions: Refer to Section 01 60 00 - Product Requirements.

B Construction:

1. Description: Boiler shall be natural gas fired, fully condensing, fire tube design. Power burner shall have full modulation (the minimum firing rate shall not exceed 50,000 BTU/HR input. Boilers that have an input greater than 50,000 BTU/Hr. at minimum fire will not be considered) and discharge into a positive pressure vent. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint.

2. Boiler shall be factory-fabricated, factory-assembled and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion-air intake connections, water supply, return and condensate drain connections, and controls.
3. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 1/2" OD, with no less than 0.035" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 6-inch diameter
4. Pressure Vessel: The pressure vessel shall have a maximum water volume of 16.25 gallons. The boiler water pressure drop shall not exceed 2.5 psig at 87 gpm. The boiler water connections shall be 3 inch flanged 150 pound, ANSI rated. The pressure vessel shall be constructed of SA53 carbon steel, with a 0.25 inch thick wall and 0.50-inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.
5. Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of a 15 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall produce less than 20 ppm of NOx corrected to 3% excess oxygen. The unit shall be certified by the South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2 for boilers and water heaters less than or equal to 2 MBTUs, and the Texas Commission on Environmental Quality (TCEQ) as being compliant with Section 117.465 for boilers and water heaters less than or equal to 2 MBTUs. The burner shall be metal fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable frequency drive (VFD), controlled cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

6. Minimum boiler efficiencies shall be as follows at a 20 degree delta-T:

EWT	100% Fire	50% Fire	5% Fire
160 °F	87%	87.3%	87.6%
120 °F	90.5%	91%	91.5%
80 °F	97.8%	98.1%	98.4%

7. The exhaust manifold shall be of corrosion resistant cast aluminum with a 6 inch diameter flue connection. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.
8. Blower. The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.
 - a. Motors: Blower motors shall comply with requirements specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
 - 1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0.

9. Ignition: Ignition shall be via regulated staged spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

C Controls:

1. Refer to Section 23 09 13 - Instrumentation and Control of HVAC.
2. The boiler control system shall be segregated into three components: "C-More" Control Panel, Power Box and Input/Output Connection Box. The entire system shall be Underwriters Laboratories recognized.
3. The control panel shall consist of six individual circuit boards using state-of-the-art surface-mount technology in a single enclosure. These circuit boards shall include:
 - a. A display board incorporating LED display to indicate temperature and a vacuum fluorescent display module for all message enunciation
 - b. A CPU board housing all control functions
 - c. An electric low-water cutoff board with test and manual reset functions
 - d. A power supply board
 - e. An ignition /stepper board incorporating flame safeguard control
 - f. A connector board
 - g. Each board shall be individually field replaceable.
4. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.
5. The control panel hardware shall support both RS-232 and RS-485 remote communications.
6. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of eight separate status messages and 34 separate fault messages.
7. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features include:
 - a. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.
 - b. Setpoint Low Limit: Setpoint low limit allows for a selectable minimum operating temperature.
 - c. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired.
8. The boiler control system shall incorporate the following additional features for enhanced external system interface:
 - a. System start temperature feature.
 - b. Pump delay timer.
 - c. Auxiliary start delay timer.
 - d. Auxiliary temperature sensor.
 - e. Analog output feature to enable simple monitoring of temperature setpoint, outlet temperature or fire rate.

- f. Remote interlock circuit.
 - g. Delayed interlock circuit.
 - h. Fault relay for remote fault alarm.
9. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD 1.
 10. Boiler Management System (BMS): The Boiler Manufacturer shall supply as part of the boiler package a completely integrated Boiler Management System Programmer to control all operation and energy input of the multiple boiler heating plant. The Boiler Management System shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the Boilers via the RS-485 port. The BMS controller shall have the ability to operate up to 32 boilers per BMS panel.
 11. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The BMS shall control the boiler outlet header temperature within +4°F. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The BMS controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.
 12. When set on Internal Setpoint Mode, temperature control setpoint on the BMS shall be fully field adjustable from 50°F to 190°F in operation. When set on Indoor/Outdoor Reset Mode, the BMS will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the BMS will operate the plant to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.
 13. When set on MODBUS Temperature Control Mode, the BMS will operate the plant to vary header temperature setpoint as an external communication utilizing the MODBUS protocol is supplied via the RS-232 port. The BMS controller shall have a vacuum fluorescent display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard. The controller will automatically balance the sequence of operating time on each boiler by a first-on first-off mode and provide for setback and remote alarm contacts. Connection between central BMS system and individual boilers shall be twisted pair low voltage wiring, with the boilers 'daisy-chained' for ease of installation.
- D Electrical Power:
1. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
 2. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.
- E Venting:
1. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with operating temperatures up to 230°F, positive pressure, condensing flue gas service. UL listed vents are PVC, CPVC, Polypropylene and AL 29-4C stainless steel.
 2. The minimum exhaust vent duct size for each boiler is six-inch diameter.

3. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the boiler and the outdoors.
 4. The minimum sealed combustion air duct size for each boiler is six-inch diameter.
 5. Common Vent and Common Combustion Air must be an available option for boiler installation. Consult manufacturer for common vent and combustion air sizing.
 6. Follow guidelines specified in manufacturer's venting guide.
- F Source Quality Control:
1. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.
 2. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
 - a. If boilers are not factory assembled and fire-tested, the local vendor is responsible for all field assembly and testing.
 3. Allow Owner access to source quality-control testing of boilers. Notify Architect fourteen days in advance of testing.

PART 3 EXECUTION

3.01 EXAMINATION

- A Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting boiler performance, maintenance and operations.
1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B Examine mechanical spaces for suitable conditions where boilers will be installed.
- C Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A Install units as detailed, and according to manufacturer's installation instructions.
- B Set units on concrete housekeeping pads.
- C Install all items shipped loose by equipment manufacturer under supervision of equipment manufacturer's field service personnel.

3.03 BOILERS

- A Install boilers level on concrete bases. Concrete base is specified in Section 23 05 00 - Common Work Results for HVAC, and concrete materials and installation requirements are specified in Division 03.
- B Install gas-fired boilers according to NFPA 54.
- C Assemble and install boiler trim.
- D Install electrical devices furnished with boiler but not specified to be factory mounted.
- E Install control wiring to field-mounted electrical devices.
- F After piping system has been flushed, boil out boilers using chemical and procedure as recommended by boiler manufacturer. Perform boil-out under supervision of boiler manufacturer's representative.
- G Manufacturer shall verify in writing that boilers have been cleaned according to their recommendations and are ready for operation.
- H Isolate boilers from piping system during boil-out.

- I Pipe vents from gas train to atmosphere. Size of each vent shall not be less than connection size to device.
- J Pipe boiler drains to nearest floor drains.
- K Owner's representative and/or Engineer will observe boil-out. Contractor must notify Engineer at least 72 hours prior to boil-out.
- L Install gas pressure gauges at downstream of gas pressure regulators.
- M If remote control panels are used, install all interconnecting wiring and pneumatic tubing if used between panels and units.

3.04 CONNECTIONS

- A Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
- B Install piping adjacent to boiler to permit service and maintenance.
- C Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D Connect gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.
- F Install piping from safety relief valves to nearest floor drain.
- G Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect venting full size to boiler connections. Comply with requirements in Section 23 51 00 - Breechings, Chimneys and Stacks.
- H Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- I Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.05 FIELD QUALITY CONTROL

- A Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- B Tests and Inspections
 - 1. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C Remove and replace malfunctioning units and retest as specified above.

- D Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E Performance Tests
 - 1. The boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the boiler manufacturer to complete the following performance tests:
 - a. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 - b. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 - c. Repeat tests until results comply with requirements indicated.
 - d. Provide analysis equipment required to determine performance.
 - e. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
 - f. Notify Architect in advance of test dates.
 - g. Document test results in a report and submit to Architect.

3.06 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

3.07 FUNCTIONAL PERFORMANCE TESTING

- A Contractor is responsible for utilizing the functional performance test procedures supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for functional performance test procedures.

3.08 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under specification Section 01 91 01 - Commissioning Process.
- B Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 4 hours.

END OF SECTION 23 52 00

SECTION 23 62 13

PACKAGED AIR-COOLED REFRIGERANT COMPRESSOR AND CONDENSING UNITS

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for air cooled condensing units for use with split system type air conditioning. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Submittals.
 - g. Operation and Maintenance Data.
 - h. Delivery, Storage and Handling.
 - i. Warranty.
 2. PART 2 – PRODUCTS.
 - a. Units 15 Tons and Larger.
 - b. Refrigerant Piping Specialties.
 - c. Refrigerant Piping Accessories.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Startup.
 - c. Construction Verification Items.
 - d. Functional Performance Testing.
 - e. Owner Training.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 00 - Common Work Results for HVAC.
C Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
D Section 23 21 13 - Hydronic Piping.

1.03 REFERENCE

- A Applicable provisions of Division 1 shall govern work under this section.

1.04 REFERENCE STANDARDS

- | | | |
|---|--------------|--|
| A | AHRI 210/240 | Unitary Air Conditioning and Heat Pump Equipment. |
| B | AHRI 365 | Commercial and Industrial Unitary Air Conditioning Condensing Units. |
| C | ASHRAE 15 | Safety Standard for Refrigeration Systems. |
| D | ASHRAE 90.1 | (2004 edition)Energy Standard for Buildings Except Low Rise Residential Buildings. |
| E | NEC | National Electrical Code. |
| F | ASTM B117 | Standard Practice for Operating Salt Spray (fog) Apparatus. |
| G | UL | Underwriters Laboratory. |

1.05 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.
- B Unit Energy Efficiency Ratio (EER), Coefficient of Performance (COP) and Integrated Part Load Value (IPLV) shall meet the minimum applicable requirements of ASHRAE 90.1(2004 edition). Units that are labeled ENERGY STAR® will be acceptable.
- C Rate unit performance in accordance with the latest edition of AHRI Standard 365 or AHRI Standard 210/240, whichever is applicable for the equipment.
- D Construct units in accordance with ASHRAE 15, UL standards and the NEC. Units shall carry the UL label.
- E Factory run test units to see that each control device operates properly. Pressure test, evacuate, charge with holding charge of refrigerant and full oil charge prior to shipping from the factory.

1.06 SUBMITTALS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Submit air cooled condensing unit shop drawings including the following information: specific manufacturer and model numbers, dimensional and weight data, required clearances, materials of construction, capacities and ratings, stages of unloading capacity achievable without hot gas bypass (and with hot gas bypass if applicable), refrigerant type and charge, component information, size and location of piping connections, electrical connections, wiring diagrams and information for all specialties and accessories.
- C Submit manufacturer's installation and startup instructions, maintenance data, troubleshooting guide, parts lists, controls and accessories.
- D At substantial completion, submit warranty certificate and copy of startup report.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.08 DELIVERY, STORAGE AND HANDLING

- A Comply with manufacturer's instructions for storing, rigging, unloading, and transporting units. Protect units from physical damage. Leave factory-shipping covers in place until installation.
- B Ship units to jobsite fully assembled.

1.09 WARRANTY

- A Provide a one year parts and labor warranty on the entire unit beginning upon substantial completion of project.
- B Provide a five year parts warranty on the compressor(s) beginning upon substantial completion of project.

PART 2 PRODUCTS

2.01 UNITS 15 TONS AND LARGER

- A Manufacturers:
 - 1. Carrier: www.carrier.com.
 - 2. Trane: www.trane.com.
 - 3. York: www.york.com.
 - 4. Daikin: www.daikinapplied.com.
 - 5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Provide factory assembled, outdoor mounted, air-cooled condensing unit suitable for on grade or rooftop installation.

- C Include compressors, air cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls, motor starting components and additional features as specified herein or required for safe, automatic operation. Capacities, number of refrigeration circuits, steps of unloading and minimum capacity without hot gas bypass shall be as indicated in the equipment schedule. The Contractor may provide multiple separate units in lieu of a single unit in order to provide the required number of steps of unloading. This Contractor is responsible for all additional costs, including electrical and controls costs, associated with multiple units. Refrigerant is to be R-**454B**. Provide hot gas bypass feature with associated accessories for low load operation.
- D CABINET:
1. Construct cabinet of heavy gauge, galvanized steel coated with paint. Cabinet must meet the 500-hour salt spray exposure test in accordance with ASTM B117. Provide lifting holes to facilitate rigging and access panels to facilitate access to all-internal areas of unit that require service or repair.
- E COMPRESSORS:
1. Provide scroll hermetic type or reciprocating semi-hermetic type compressors.
 2. Scroll compressors: Direct drive suction cooled motor. Provide oil level sight glass, suction service valve, liquid line shut off valve with charging port for each compressor circuit.
 3. Reciprocating Compressors: Provide serviceable compressors equipped with force-fed lubrication system, suction and discharge shutoff valves, high side pressure relief device, liquid line shutoff valves, liquid line sight glass, oil level site glass, suction line filter dryer, hot gas bypass stub tubes and crankcase heater. Mount compressors on vibration isolators. Compressors shall unload using electric solenoid unloading.
- F CONDENSER:
1. Provide condenser coils with aluminum alloy plate fins mechanically fastened to seamless copper tubing with integral subcooler. Construct coils with design working pressure suitable for refrigerant selected.

Provide direct-drive statically and dynamically balance propeller type fans with vertical discharge and guards constructed of heavy gage PVC coated or galvanized steel. Provide motors with built in current protection and permanently lubricated sealed ball bearings.
- G POWER:
1. Provide factory installed 24-volt control circuit with fusing, control power transformer and all associated internal wiring. Provide a single point power connection to the unit(s). Provide factory installed magnetic contactors for compressor and condenser motors, three-leg compressor overload protection and single phasing condition protection with manual reset. Electrical characteristics shall be as indicated in the equipment schedule.
- H CONTROLS:
1. Provide manufacturer controls for control of compressor stages. Controls to be capable of BACNet communication with DDC system.
 2. Provide high/low refrigerant pressure cutouts with manual reset and anti-shortcycle compressor timer.
 3. Unit must be capable of operating down to ambient temperature of 40 deg F. Provide low ambient lockout to prevent compressor from operating below 40 degrees.
- I CONVENIENCE OUTLET:
1. Outlet shall be factory-installed and internally mounted with easily accessible 115-v female receptacle.

2. Outlet shall include 15 amp GFI (ground fault interrupter) receptacles with independent fuse protection. Voltage required to operate convenience outlet shall be provided by a factory-installed step-down transformer. Outlet shall be accessible from outside the unit.

2.02 REFRIGERANT PIPING SIZING

- A The unit manufacturer shall verify the *final refrigeration pipe sizing* process to ensure conformance to specific unit requirements such as max lengths, refrigerant velocities, unloading considerations and proper oil return. This Contractor shall provide refrigeration piping drawings from the field which details the way the piping will actually be installed.

2.03 REFRIGERANT PIPING ACCESSORIES

- A Provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 450 psig and a maximum working temperature of 225 deg F. For systems using R-410A, provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 850 psig and a maximum working temperature of 225 deg F.
- B Flexible pipe connectors: Double braided bronze hose flexible pipe connectors with solder end connections.
- C Filter Dryers: For circuit's 15 tons and over provide angle pattern filter dryers with replaceable core. For circuits below 15 tons provide straight pattern filter dryers without replaceable core.
- D Sight glasses: Two piece brass construction with solder end connections. Include color indicator for sensing moisture.
- E Solenoid Valves: Two way normally closed with two piece brass body, full port, stainless steel plug, stainless steel spring, teflon diaphragm and solder end connections. Provide replaceable coil assembly.
- F Hot Gas Bypass Valves: Provide with integral solenoid valve, external equalizer connection and adjustable pilot assembly.
- G Thermostatic Expansion Valves: Brass body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.
- H Charging Valves: Provide 1/4 inch SAE brass male flare access ports with finger tight, quick seal caps. Provide 2 inch long copper extension sections.
- I Check valves: Spring loaded type with bronze body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install units, piping and accessories in accordance with the manufacturer's written instructions and recommendations. Mount unit(s) on roof mounted rails as indicated on the drawings.
- B Maintain adequate service access and airflow clearances for all components as recommended by the manufacturer and as indicated on the drawings.
- C Charge unit(s) with full oil charge and refrigerant charge based on the entire refrigeration system pipe size and length.
- D Provide all control wiring in conduit in compliance with Section 23 09 13 and Division 26 - Electrical.
- E Coordinate power wiring requirements with the electrical trade.

3.02 STARTUP

- A Adjust units for maximum operating efficiency, adjust all controls to required final settings and demonstrate that all components are functioning properly. Submit four copies of a written startup report following the initial startup.

- B Include in the report: work done to the system, all readings taken, a statement certifying that the refrigeration system(s) are leak free and a statement certifying that the unit(s) have been placed in proper running condition as recommended by the manufacturer and as intended in the drawings and specifications.

3.03 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

3.04 FUNCTIONAL PERFORMANCE TESTING

- A Contractor is responsible for utilizing the functional performance test procedures supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for functional performance test procedures.

3.05 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under specification Section 01 91 01 - Commissioning Process.
- B Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 4 hours.

END OF SECTION 23 62 13

INTENTIONALLY LEFT BLANK

SECTION 23 73 12 AIR HANDLING UNIT COILS

PART 1 GENERAL

1.01 SCOPE

- A This section contains specifications for coils used in all central station air handling units and field erected air handling units, whether located indoors, or outdoors. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Submittals.
 - g. Operation and Maintenance Data.
 - h. Design Criteria.
 - i. Warranty.
 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Hot Water Coils.
 - c. Refrigerant Coils.
 3. PART 3 – EXECUTION.
 - a. Hot Water Coils.
 - b. Refrigerant Coils.
 - c. Construction Verification Items.
 - d. Owner Training.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units.
C Section 23 82 00 - Heating and Cooling Terminal Units.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A ARI 410 - Forced Circulation Air-Cooling and Air-Heating Coils.

1.05 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.06 SUBMITTALS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
B Including data concerning dimensions, capacities, flow rate, pressure drop, materials of construction, ratings, weights, and appropriate identification at the same time that the air handling equipment in which the coils will be located are submitted.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.08 DESIGN CRITERIA

- A Select coil sizes, capacities, configuration, and operating characteristics as shown on the plans and/or as scheduled. Coil capacity ratings shall be ARI 410 certified.

1.09 WARRANTY

- A Provide a manufacturer's parts and labor warranty against factory defects in material and workmanship for a period of one year after startup.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Aerofin: www.aerofin.com.
- B Carrier: www.carrier.com.
- C Daikin: www.daikinapplied.com.
- D RAE Corporation: www.rae-corp.com.
- E Trane: www.trane.com.
- F York: www.york.com.
- G Marlo: www.marolcoil.com.
- H Wing: www.ljwing.com.
- I Control Air: www.controlair.com.
- J Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.02 HOT WATER COILS

- A Use galvanized steel casing, end supports, top channel, and bottom channel to produce a rigid frame with allowance for expansion and contraction of the finned tube section.
- B Construct coils of 0.025 inch tube wall seamless copper tubes of 5/8 inch maximum outside diameter with maximum of 8 aluminum fins per inch suitable for working pressures to 125 psig and temperatures to 250°F. Coil fins may be the continuous serpentine or plate fin type.
- C Coil headers may be constructed of cast iron, steel, or seamless copper. Where cast iron headers are used, expand tubes into the headers. Where steel or copper headers are used braze tubes to header.
- D Provide coils with bronze spring turbulators where required to provide the capacities indicated.

2.03 REFRIGERANT COILS

- A Use galvanized steel casing, end supports, top channel, and bottom channel to produce a rigid frame with allowance for expansion and contraction of the finned tube section.
- B Construct coils of minimum 1/2 inch outside diameter copper tubes with aluminum fins. Test at 250 psig, dehydrate, purge with inert gas, and seal prior to shipment.
- C Construct suction header of seamless copper tubing. Use a low pressure drop venturi type distributor to distribute refrigeration equally to multiple circuits.
- D Coil fins shall be the continuous serpentine or plate fin type.

PART 3 EXECUTION

3.01 HOT WATER COILS

- A Install in central station air handling unit casings or on structural support frames for field erected units, making allowance for pitching as recommended by the manufacturer. Mount coils in field erected units to allow for individual removal.
- B Comb bent or crushed fins after installation. Clean dust and debris from each coil to ensure its cleanliness.
- C Install a separate air vent and drain valve for each coil header in such a manner that the vent and drain valves are located outside of air handling unit casing. Provide offsets in piping to facilitate coil removal.
- D Unless otherwise specified, pipe coils for counter flow arrangement.

3.02 REFRIGERANT COILS

- A Install in central station air handling unit casings or on structural support frames for field erected units, making allowance for pitching as recommended by the manufacturer. Mount coils in field erected units to allow for individual removal.
- B Comb bent or crushed fins after installation. Clean dust and debris from each coil to ensure its cleanliness.
- C Install refrigerant specialties as detailed and in accordance with manufacturer's instructions. Provide offsets in piping to facilitate coil removal.
- D Where coils are installed in ductwork or field erected air handling units, provide a 1-1/2 inch deep 18 gauge welded stainless steel drain pan as an integral part of the duct or at coil support.
- E Install condensate drain trap with proper depth from each cooling coil condensate drain to the nearest drain location.
- F Make sure there is sufficient depth below air handling unit cooling coils to obtain the proper depth of trap; spring vibration isolators or housekeeping pads will not provide sufficient height.

3.03 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

3.04 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under specification Section 01 91 01 - Commissioning Process.

END OF SECTION 23 73 12

INTENTIONALLY LEFT BLANK

SECTION 23 73 13
MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SCOPE

- A This section includes specifications for indoor central station package air handling units. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Submittals.
 - g. Operation and Maintenance Data.
 - h. Design Criteria.
 - i. Warranty.
 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Casings.
 - c. Fans.
 - d. Coils.
 - e. Filter Section.
 - f. Access Sections.
 - g. Filter/Mixing Box Section.
 - h. Damper Section.
 - i. Air Blender Section.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Construction Verification Items.
 - c. Functional Performance Testing.
 - d. Owner Training.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
C Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
D Section 23 73 12 - Air Handling Unit Coils.
E Section 23 41 00 - Particulate Air Filtration.
F Section 23 33 00 - Air Duct Accessories.
G Section 23 05 14 - Variable Frequency Drives.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A AHRI 430 (latest edition) - Standard for Performance Rating of Central Station Air Handling Units.
- B AHRI 260-2012 - Sound Rating of Ducted Air Moving and Conditioning Equipment.
- C AHRI 410-2001 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- D AMCA 201-02 (R2011) - Fans and Systems.
- E AMCA 203-90 (R2011) - Field Performance Measurement of Fan Systems.
- F AMCA 210-07 - Laboratory Methods of Testing Fans For Certified Aerodynamic Performance Rating.
- G AMCA 500-L-07 - Laboratory Methods of Testing Louvers for Rating.
- H AMCA 611-10 - Certified Ratings Program – Product Rating Manual For Airflow Measurement Stations.
- I NFPA 90A - Standard for Installation of Air Conditioning and Ventilation Systems.

1.05 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.06 SUBMITTALS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Submit shop drawings including the following information: specific manufacturer and model numbers, submittal equipment identification corresponding to project drawings and schedules, unit dimensional and weight data, materials of construction, capacities and ratings, fan curves, fan type, drive and motor information (ref. 23 05 13), vibration isolation, coil performance data, sound power levels, filter information (ref. 23 41 00), information for all accessories.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.08 DESIGN CRITERIA

- A Furnish factory fabricated packaged air handling units complete with fans, motors, drives, coils, drain pans, filter sections, access sections, damper sections, meeting the configuration shown on drawings and/or as scheduled.
- B Units to be tested rated and certified in accordance with AHRI Standard 430 and bear AHRI certification label.
- C All material shall meet NFPA 90A flame spread and smoke develop rating requirements.
- D Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. The motor furnished with the fan shall not operate into the motor service factor when operating under these conditions.
- E Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.
- F Where inlet and outlet ductwork at any fan is changed from that shown on the drawings, provide any motor, drive and/or wiring changes required due to increased static pressure or baffling necessary to prevent uneven airflow or improve mixing.

1.09 WARRANTY

- A Provide a manufacturer's parts and labor warranty against factory defects in material and workmanship for the entire unit for a period of one year after startup.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Carrier: www.carrier.com.
- B Daikin: www.daikinapplied.com.

- C Trane: www.trane.com.
- D York: www.york.com.
- E Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.02 CASING

- A Double wall construction with heavy gauge steel framework and panels throughout mounted on an integral base rail. Casing shall have 2 inch thick, non-compressed, 1-1/2 lb./cu.ft. fiberglass thermal insulation between solid exterior and solid interior steel panels for all sections. Panels shall be gasketed and removable without affecting integrity of casing structure. Casing shall be airtight, watertight, rust inhibited with baked enamel or mill galvanized finish.
- B Access doors shall be double wall, of same construction and thickness as casing, hinged, continuously gasketed, with reinforced nylon handles. Door swing shall open in direction against pressure of unit. Provide access doors on both sides of casing for fan section, access sections, filter sections, damper sections and upstream and downstream of every coil. Provide windows in access doors and lights for fan sections on units above 10,000 CFM.
- C Double wall, insulated drain pans shall be located below cooling coil section. Pans shall be sloped for removal of condensate. Provide drain connection on both sides of casing.

2.03 FANS

- A Double width, double inlet, centrifugal type, statically and dynamically balanced. For variable speed applications, fan shall be dynamically balanced through entire range of operation. Fan wheels shall be backward inclined, forward curved or airfoil type as specified or required by performance characteristics.
- B Fans to be fastened to hollow or solid steel shafts and designed for continuous operation at maximum rated static pressure.
- C Fan bearings shall be self-aligning, pillow block, regreasable ball type selected for a minimum average L-50 life of 200,000 hours. Furnish extended grease lines from bearings to allow servicing from exterior of unit.
- D Furnish variable pitch sheaves for drives 3 hp and smaller, fixed pitch sheaves for drives 5 hp and larger. Drives shall be designed for 150% of motor rating.
- E Fan, drive and motor assembly shall be mounted inside fan casing section and integrally isolated within unit. Vibration isolation shall be in compliance with section 23 05 48. Provide flexible connection and thrust restraints at fan discharge connection to casing.

2.04 COILS

- A Air handling unit coils mounted in casing shall be accessible for removal from either side of unit casing without disturbing adjacent sections.
- B Entire coil frame, headers and U-bends shall be enclosed within air handling unit casing. Extend coil piping connections, air vent and drain connections to exterior of casing. Provide sealing collars to prevent leakage where coil connections, air and drain connections penetrate air handling unit casing.
- C Support coils along entire length within casing and pitch coil for proper drainage.
- D Blank off space between coil frames and air handling unit casing.

2.05 FILTER SECTION

- A Filters shall be provided in accordance with section 23 41 00.
- B Filter box section may be furnished by air handling unit manufacturer in accordance with specification requirements of section 23 41 00. Filter box sections furnished by air handling unit manufacturer shall be of same construction as casing specified above.

- C Provide static pressure taps that are arranged to prevent damage to the filter elements during replacement. Provide minimum 2 inch gap between final and prefilters for static pressure probes.

2.06 ACCESS SECTIONS

- A Same construction as casing with access doors as specified above on both sides of access section.
- B Provide access sections where shown on drawings.

2.07 FILTER/MIXING BOX SECTION

- A Same construction as casing with access doors as specified above on both sides of filter/mixing box section.
- B Filters shall be horizontal V-bank arrangement and shall meet specification requirements of section 23 41 00.
- C Outside air and return air dampers shall be parallel blade type with interconnecting linkage. Dampers shall be low leakage, not exceeding 5 cfm/sq. ft. at 1.0" w.g. Damper blades shall be double-skin airfoil type, with blade edge seals and metal compressible jamb seals. The damper blades shall be arranged so that the air streams are directed at one another to facilitate mixing. Damper linkage shall be extended outside the unit for external actuator mounting. Internal actuator mounting is not acceptable.
- D Reference drawings for damper arrangement top and bottom.
- E Reference section 23 09 13 for damper actuation.

2.08 DAMPER SECTION

- A Same construction as casing with access doors as specified above on both sides of damper section.
- B Outside air and return air dampers shall be parallel blade type with interconnecting linkage. Dampers shall be low leakage, not exceeding 5 cfm/sq. ft. at 1.0" w.g. Damper blades shall be double-skin airfoil type, with blade edge seals and metal compressible jamb seals. Damper linkage shall be extended outside the unit for external actuator mounting. Internal actuator mounting is not acceptable.
- C Reference drawings for damper arrangement top and bottom.
- D Reference section 23 09 14 and 23 09 15 for damper actuation.

2.09 AIR BLENDER SECTION

- A Same construction as casing with access doors as specified above on both sides of air blender section.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install all air handling units and accessories as indicated on drawings and/or as scheduled and according to manufacturer's installation instructions.
- B Mount units at appropriate height above floor to ensure proper condensate trap depth and condensate drainage.
- C Install air-handling unit to provide for adequate service access. Coordinate with other trades to assure air handling unit does not infringe upon access or service clearances of other equipment.
- D Lubricate fan bearings. Verify fan isolators have proper deflection.
- E Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning components, then retest to demonstrate compliance.
- F Furnish one spare set of fan drive belts and three reinforced nylon access door handles.

3.02 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

3.03 FUNCTIONAL PERFORMANCE TESTING

- A Contractor is responsible for utilizing the functional performance test procedures supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for functional performance test procedures.

3.04 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under specification Section 01 91 01 - Commissioning Process.

END OF SECTION 23 73 13

INTENTIONALLY LEFT BLANK

SECTION 23 82 00 HEATING AND COOLING TERMINAL UNITS

PART 1 GENERAL

1.01 SCOPE

- A This section includes specification for heating and cooling terminal equipment using water and/or steam as the source. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operation and Maintenance Data.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Reheat Coils.
 - b. Unit Heaters.
 - c. Cabinet Heaters.
 - d. Fin Tube Radiation.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Reheat Coils.
 - c. Unit Heaters.
 - d. Cabinet Heaters.
 - e. Fin Tube Radiation.
 - f. Construction Verification Items.
 - g. Functional Performance Testing.
 - h. Owner Training.

1.02 RELATED WORK

- A Section 01 91 01 - Commissioning Process.
B Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
C Section 23 05 23 - General-Duty Valves for HVAC Piping.
D Section 23 36 00 - Air Terminal Units.
E Section 23 41 00 - Particulate Air Filtration.

1.03 REFERENCE

- A Applicable provisions of Division 1 govern work under this Section.

1.04 REFERENCE STANDARDS

- A AHRI 210 Standard for Unitary Air-Conditioning Equipment.
B AHRI 410 Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
C CS 140.

1.05 QUALITY ASSURANCE

- A Refer to Section 01 40 00 - Quality Requirements.

1.06 SHOP DRAWINGS

- A Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Include dimensions, capacities, and materials of construction, ratings, weights, wiring diagrams, and appropriate identification for all equipment in this section. Include color selection chart where applicable.

1.07 OPERATION AND MAINTENANCE DATA

- A All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.08 DESIGN CRITERIA

- A Forced Circulation Coils: Ratings certified in accordance with AHRI 410.
- B Electrical Equipment and heaters shall be UL listed for the service specified.
- C Electrical components and work must be in accordance with National Electrical Code.

PART 2 PRODUCTS

2.01 REHEAT COILS

- A Manufacturers:
 - 1. Carrier: www.carrier.com.
 - 2. Trane: www.trane.com.
 - 3. Daikin: www.daikinapplied.com.
 - 4. Marlo: www.marlocoil.com.
 - 5. York: www.york.com.
 - 6. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Construct coils of copper tubes and aluminum fins in a serpentine arrangement with piping connections on the same end. Provide galvanized steel casing, end supports, top and bottom channels to allowance for expansion of finned tube section. Factory test coils at 200 psig.
- C Headers may be cast iron with tubes expanded into the header, steel pipe with tubes brazed to the header, or seamless copper with tubes brazed to the header.
- D Frames to be flanged for a gasketed connection to adjacent ductwork or constructed for slip and drive connection to the ductwork.
- E Minimum reheat coil size is 8 inches x 8 inches.

2.02 UNIT HEATERS

- A Manufacturers:
 - 1. Modine: www.modine.com.
 - 2. Daikin: www.daikinapplied.com.
 - 3. Trane: www.trane.com.
 - 4. Airtherm: www.airthermhvac.com.
 - 5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Construct casing of 18 gauge steel with baked enamel finish and heating elements of copper tubing with aluminum fins. Use aluminum fan blades, balanced for quiet operation. Provide safety guard for fan/drive assembly. Test coils units at 200 psig.
- C Furnish adjustable horizontal and vertical discharge louvers for units with horizontal discharge. Provide an adjustable cone diffuser for projection units with vertical discharge.
- D Furnish motors with characteristics as scheduled. Single phase, 120 volt motors to be permanently lubricated and provided with thermal overload protection.

2.03 CABINET HEATERS

- A Manufacturers:
 - 1. American Air Filter: www.americanairfilter.com.
 - 2. Sterling: www.sterlinghvac.com.
 - 3. Daikin: www.daikinapplied.com.
 - 4. Trane: www.trane.com.
 - 5. Airtherm: www.airthermhvac.com.
 - 6. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Construct vertical unit casings with 16 gauge steel front panels and minimum 18 gauge steel end and side panels. Horizontal units located in concealed spaces or mounted in ceiling to have minimum 18 gauge front, end, and side panels.
- C Furnish exposed cabinets in a baked enamel finish in one of the manufacturer's standard colors, selected by the Engineer.
- D Furnish ceiling mounted units with a hinged front panel to allow access to all internal components.
- E Construct heating elements of copper tubes with aluminum fins, tested at 200 psig.
- F Use centrifugal type fans, statically and dynamically balanced to operate without objectionable noise and vibration.
- G Motors to be 120 volt, single phase, permanently lubricated, with thermal overload protection and disconnect switch at unit.
- H Furnish each unit with filter rack and 1 inch panel filters as specified in Section 23 41 00.

2.04 FIN TUBE RADIATION

- A Manufacturers:
 - 1. Slant/Fin: www.slantfin.com.
 - 2. Sterling: www.sterlinghvac.com.
 - 3. Trane: www.trane.com.
 - 4. Vulcan: www.vulcanrad.com.
 - 5. Rittling: www.rittling.com.
 - 6. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B Construct heating elements of steel fin on steel tube or aluminum fin on copper tube. Provide wall mounted support cradles which allow expansion of heating element without noise.
- C Enclosures: Sloped top with die formed grilles. Constructed with removable front panels of 16 gauge steel, 20 gauge steel back panels, and furnished with a baked enamel finish in one of the manufacturer's standard colors, selected by Engineer.
- D Provide dirt gasket for mounting between back panel and wall.
- E Provide accessories such as inside and outside corners and end caps where required for the complete installation. Where wall-to-wall installations are indicated on plans, provide enclosure extensions or field modification of enclosure to conform to actual room dimensions.
- F Provide hinged access doors at all valves, traps, and vents.

PART 3 PART 3 EXECUTION

3.01 INSTALLATION

- A Install units in accordance with manufacturer's installation instructions.
- B Install branch water or steam/condensate piping to each unit with a minimum of three elbows to allow for expansion and contraction of the piping system.
- C Coordinate location of units with other trades to assure correct recess size for recessed units.

- D After installation, provide protective covers to prevent accumulation of dirt on units during balance of construction.

3.02 REHEAT COILS

- A Comb bent or crushed fins and clean dust and debris from each coil before enclosing coils in ductwork. Pitch coil casings in accordance with manufacturer's instructions. Install a drain valve on the coil side of the shutoff valves for each reheat coil.
- B Pipe coils with multiple rows for counter flow arrangement.

3.03 UNIT HEATERS

- A Suspend units from building structure and as high as possible to maintain headroom beneath units; supporting from piping systems will not be accepted.
- B Install a drain valve on the coil side of the shutoff valves for each hot water unit heater.

3.04 CABINET HEATERS

- A Mount units in locations indicated on the drawings and as detailed. Install a drain valve on the coil side of the shutoff valves for each hot water cabinet heater.

3.05 FIN TUBE RADIATION

- A Install dirt guard gasket to mounting strip or caulk along top of mounting strip.
- B Install a drain valve on the radiation side of the shutoff valves for each separately valved section of radiation.
- C Install access doors or panels, centered in front of each shut-off valve, balancing valve, steam trap, and temperature control valve located inside radiation enclosure.

3.06 CONSTRUCTION VERIFICATION ITEMS

- A Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for construction verification checklists.

3.07 FUNCTIONAL PERFORMANCE TESTING

- A Contractor is responsible for utilizing the functional performance test procedures supplied under specification Section 01 91 01 - Commissioning Process in accordance with the procedures defined for functional performance test procedures.

3.08 OWNER TRAINING

- A All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under specification Section 01 91 01 - Commissioning Process.

END OF SECTION 23 82 00

SECTION 26 00 10
SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

- A This Section specifies supplemental requirements generally applicable to the Work specified in Division 26. This Section is also referenced by related Work specified in other Divisions.
- B Related Requirements:
 - 1. Section 260011 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.02 REFERENCES

- A Abbreviations and Acronyms for Electrical Terms and Units of Measure:
 - 1. 8P8C: An 8-position 8-contact modular jack.
 - 2. A: Ampere, unit of electrical current.
 - 3. AC or ac: Alternating current.
 - 4. AFCI: Arc-fault circuit interrupter.
 - 5. AIC: Ampere interrupting capacity.
 - 6. AL, Al, or ALUM: Aluminum.
 - 7. ASD: Adjustable-speed drive; also called "variable-frequency drive" (VFD).
 - 8. ATS: Automatic transfer switch.
 - 9. AWG: American wire gauge; see ASTM B258.
 - 10. BAS: Building automation system.
 - 11. BIL: Basic impulse insulation level.
 - 12. BIM: Building information modeling.
 - 13. CAD: Computer-aided design or drafting.
 - 14. CATV: Community antenna television.
 - 15. CB: Circuit breaker.
 - 16. cd: Candela, the SI fundamental unit of luminous intensity.
 - 17. COPS: Critical operations power system.
 - 18. CU or Cu: Copper.
 - 19. DC or dc: Direct current.
 - 20. DCOA: Designated critical operations area.
 - 21. DDC: Direct digital control (HVAC).
 - 22. EGC: Equipment grounding conductor.
 - 23. ELV: Extra-low voltage.
 - 24. EMF: Electromotive force.
 - 25. EMI: Electromagnetic interference.
 - 26. EPM: Electrical preventive maintenance.
 - 27. EPS: Emergency power supply.
 - 28. EPSS: Emergency power supply system.

29. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion $1 \text{ fc} = 10 \text{ lx}$ in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
30. FLC: Full-load current.
31. ft: Foot.
32. ft-cd: Foot-candle, the antiquated U.S. Standard unit of illuminance, equal to one international candle measured at a distance of one foot, that was superseded in 1948 by the unit "footcandle" after the SI unit candela (cd) replaced the international candle; see "fc,"
33. GEC: Grounding electrode conductor.
34. GFCI: Ground-fault circuit interrupter.
35. GFPE: Ground-fault protection of equipment.
36. GND: Ground.
37. HACR: Heating, air conditioning, and refrigeration.
38. HDPE: High-density polyethylene.
39. HID: High-intensity discharge.
40. HP or hp: Horsepower.
41. HVAC: Heating, ventilating, and air conditioning.
42. Hz: Hertz.
43. IBT: Intersystem bonding termination.
44. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
45. IP: Ingress protection rating (enclosures); Internet protocol (communications).
46. IR: Infrared.
47. IS: Intrinsically safe.
48. IT&R: Inspecting, testing, and repair.
49. ITE: Information technology equipment.
50. kAIC: Kiloampere interrupting capacity.
51. kcmil or MCM: One thousand circular mils.
52. kV: Kilovolt.
53. kVA: Kilovolt-ampere.
54. kVA_r or kVAR: Kilovolt-ampere reactive.
55. kW: Kilowatt.
56. kWh: Kilowatt-hour.
57. LAN: Local area network.
58. lb: Pound (weight).
59. lbf: Pound (force).
60. LCD: Liquid-crystal display.
61. LCDI: Leakage-current detector-interrupter.
62. LED: Light-emitting diode.
63. Li-ion: Lithium-ion.
64. lm: Lumen, the SI derived unit of luminous flux.
65. LNG: Liquefied natural gas.
66. LP-Gas: Liquefied petroleum gas.

67. LRC: Locked-rotor current.
68. LV: Low voltage.
69. lx: Lux, the SI derived unit of illuminance equal to one lumen per square meter.
70. m: Meter.
71. MIDI: Musical instrument digital interface.
72. MLO: Main lugs only.
73. MV: Medium voltage.
74. MVA: Megavolt-ampere.
75. mW: Milliwatt.
76. MW: Megawatt.
77. MWh: Megawatt-hour.
78. NC: Normally closed.
79. Ni-Cd: Nickel-cadmium.
80. Ni-MH: Nickel-metal hydride.
81. NIU: Network interface unit.
82. NO: Normally open.
83. NPT: National (American) standard pipe taper.
84. OCPD: Overcurrent protective device.
85. ONT: Optical network terminal.
86. PC: Personal computer.
87. PCS: Power conversion system.
88. PCU: Power-conditioning unit.
89. PF or pf: Power factor.
90. PHEV: Plug-in hybrid electric vehicle.
91. PLC: Programmable logic controller.
92. PLFA: Power-limited fire alarm.
93. PoE: Power over Ethernet.
94. PV: Photovoltaic.
95. PVC: Polyvinyl chloride.
96. pW: Picowatt.
97. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
98. RMS or rms: Root-mean-square.
99. RPM or rpm: Revolutions per minute.
100. SCADA: Supervisory control and data acquisition.
101. SCR: Silicon-controlled rectifier.
102. SPD: Surge protective device.
103. sq.: Square.
104. SWD: Switching duty.
105. TCP/IP: Transmission control protocol/Internet protocol.
106. TEFC: Totally enclosed fan-cooled.
107. TR: Tamper resistant.
108. TVSS: Transient voltage surge suppressor.
109. UL: (standards) Underwriters Laboratories, Inc.; (product categories) UL, LLC.

110. UL CCN: UL Category Control Number.
111. USB: Universal serial bus.
112. UV: Ultraviolet.
113. V: Volt, unit of electromotive force.
114. V(ac): Volt, alternating current.
115. V(dc): Volt, direct current.
116. VA: Volt-ampere, unit of complex electrical power.
117. VAR: Volt-ampere reactive, unit of reactive electrical power.
118. VFC: Variable-frequency controller.
119. VOM: Volt-ohm-multimeter.
120. VPN: Virtual private network.
121. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
122. W: Watt, unit of real electrical power.
123. Wh: Watt-hour, unit of electrical energy usage.
124. WPT: Wireless power transfer.
125. WPTE: Wireless power transfer equipment.
126. WR: Weather resistant.

B Abbreviations and Acronyms for Electrical Raceway Types:

1. CR: Communications raceway.
2. CR-GP: General-purpose communications raceway.
3. CR-P: Plenum communications raceway.
4. CR-R: Riser communications raceway.
5. EMT: Electrical metallic tubing.
6. EMT-S: Steel electrical metallic tubing.
7. EMT-SS: Stainless steel electrical metallic tubing.
8. ENT: Electrical nonmetallic tubing.
9. EPEC: Electrical HDPE underground conduit (thin wall).
10. EPEC-A: Type A electrical HDPE underground conduit.
11. EPEC-B: Type B electrical HDPE underground conduit.
12. ERMC: Electrical rigid metal conduit.
13. ERMC-A: Aluminum electrical rigid metal conduit.
14. ERMC-S: Steel electrical rigid metal conduit.
15. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
16. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
17. ERMC-SS: Stainless steel electrical rigid metal conduit.
18. FMC: Flexible metal conduit.
19. FMC-A: Aluminum flexible metal conduit.
20. FMC-S: Steel flexible metal conduit.
21. FMT: Steel flexible metallic tubing.
22. FNMC: Flexible nonmetallic conduit. See "LFNC."
23. HDPE: HDPE underground conduit (thick wall).

24. HDPE-40: Schedule 40 HDPE underground conduit.
 25. HDPE-80: Schedule 80 HDPE underground conduit.
 26. IMC: Steel electrical intermediate metal conduit.
 27. LFMC: Liquidtight flexible metal conduit.
 28. LFMC-A: Aluminum liquidtight flexible metal conduit.
 29. LFMC-S: Steel liquidtight flexible metal conduit.
 30. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
 31. LFNC: Liquidtight flexible nonmetallic conduit.
 32. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
 33. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
 34. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
 35. OFR: Optical fiber raceway.
 36. OFR-GP: General-purpose optical fiber raceway.
 37. OFR-P: Plenum optical fiber raceway.
 38. OFR-R: Riser optical fiber raceway.
 39. PVC: Rigid PVC conduit.
 40. PVC-40: Schedule 40 rigid PVC conduit.
 41. PVC-80: Schedule 80 rigid PVC Conduit.
 42. PVC-A: Type A rigid PVC concrete-encased conduit.
 43. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
 44. RGS: See ERM-C-S-G.
 45. RMC: See ERM-C.
 46. RTRC: Reinforced thermosetting resin conduit.
 47. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
 48. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
 49. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
 50. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
 51. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.
- C Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:
1. AC: Armored cable.
 2. CATV: Coaxial general-purpose cable.
 3. CATVP: Coaxial plenum cable.
 4. CATVR: Coaxial riser cable.
 5. CI: Circuit integrity cable.
 6. CL2: Class 2 cable.
 7. CL2P: Class 2 plenum cable.
 8. CL2R: Class 2 riser cable.
 9. CL2X: Class 2 cable, limited use.
 10. CL3: Class 3 cable.
 11. CL3P: Class 3 plenum cable.
 12. CL3R: Class 3 riser cable.
 13. CL3X: Class 3 cable, limited use.

14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MI: Mineral-insulated, metal-sheathed cable.
30. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
31. MV: Medium-voltage cable.
32. NM: Nonmetallic sheathed cable.
33. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
34. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
35. NPLF: Non-power-limited fire-alarm circuit cable.
36. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
37. NPLFR: Non-power-limited fire-alarm circuit riser cable.
38. NUCC: Nonmetallic underground conduit with conductors.
39. OFC: Conductive optical fiber general-purpose cable.
40. OFCG: Conductive optical fiber general-purpose cable.
41. OFCP: Conductive optical fiber plenum cable.
42. OFCR: Conductive optical fiber riser cable.
43. OFN: Nonconductive optical fiber general-purpose cable.
44. OFNG: Nonconductive optical fiber general-purpose cable.
45. OFNP: Nonconductive optical fiber plenum cable.
46. OFNR: Nonconductive optical fiber riser cable.
47. P: Marine shipboard cable.
48. PLTC: Power-limited tray cable.
49. PLTC-ER: Power-limited tray cable, exposed run.
50. PV: Photovoltaic cable.
51. RHH: (high heat) Thermoset rubber, heat-resistant cable.
52. RHW: Thermoset rubber, moisture-resistant cable.
53. SA: Silicone rubber cable.
54. SE: Service-entrance cable.

55. SER: Service-entrance cable, round.
 56. SEU: Service-entrance cable, flat.
 57. SIS: Thermoset cable for switchboard and switchgear wiring.
 58. TBS: Thermoplastic cable with outer braid.
 59. THW: Thermoplastic, heat- and moisture-resistant cable.
 60. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
 61. THHW: Thermoplastic, heat- and moisture-resistant cable.
 62. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
 63. TW: Thermoplastic, moisture-resistant cable.
 64. UF: Underground feeder and branch-circuit cable.
 65. USE: Underground service-entrance cable.
 66. XHH: Cross-linked polyethylene, heat-resistant cable.
 67. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.
- D Abbreviations and Acronyms for Electrical Flexible Cord Types:
1. SEO: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
 2. SEOW: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
 3. SEOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
 4. SEOOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
 5. SJEO: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
 6. SJEOO: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
 7. SJEOOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
 8. SJEOOOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
 9. SJO: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp locations.
 10. SJOW: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
 11. SJOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp locations.
 12. SJOOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
 13. SJTO: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
 14. SJTOW: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.

15. SJTOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
16. SJTOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
17. SO: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp locations.
18. SOW: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
19. SOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp locations.
20. SOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
21. STO: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
22. STOW: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.
23. STOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
24. STOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.

E Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted-pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."
 - a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.
2. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
3. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
4. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
5. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
6. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.

7. Designated Seismic System: A system component that requires design in accordance with Ch. 13 of ASCE/SEI 7 and for which the Component Importance Factor is greater than 1.0.
8. Direct Buried: Installed underground without encasement in concrete or other protective material.
9. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:
 - a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
 - b. Concrete Box: A box intended for use in poured concrete.
 - c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
 - d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
 - e. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
 - f. Device Box: A box with provisions for mounting a wiring device directly to the box.
 - g. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
 - h. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
 - i. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
 - j. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
 - k. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
 - l. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
 - m. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
 - n. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
 - o. Raised-Floor Box: A floor box intended for use in raised floors.
 - p. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
 - q. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.

- r. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
 - s. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
 - t. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.
10. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
 11. Essential Electrical Systems: (healthcare facilities) 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.
 12. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.
 - a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.
 13. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
 14. Jacket: A continuous nonmetallic outer covering for conductors or cables.
 15. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
 16. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
 17. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
 18. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
 19. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
 20. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
 21. Sheath: A continuous metallic covering for conductors or cables.
 22. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
 23. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

- a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
 - b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
 - c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
 - d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
 - e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
 - f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.
24. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.03 COORDINATION

- A Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:
1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Construction Manager's Owner's written permission.
 3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:
 - a. Exercising generators.
 - b. Emergency lighting.
 - c. Fire-alarm systems.
- B Arrange to provide temporary electrical power in accordance with requirements specified in Division 01.

1.04 SEQUENCING

- A Conduct and submit results of power system studies before submitting Product Data and Shop Drawings for electrical equipment.

1.05 ACTION SUBMITTALS

- A Coordination drawings.

1.06 INFORMATIONAL SUBMITTALS

- A Electrical installation schedule.
B Qualification statements.

1.07 CLOSEOUT SUBMITTALS

1.08 QUALITY ASSURANCE

- A Qualifications: Prepare and submit qualification statements for the following entities performing Work on Project:
1. Qualified Regional Manufacturer: Manufacturer, possessing "Quality Requirements," that maintains a service center capable of providing training, parts, and emergency on-site repairs to Project site with response time less than eight hours.
 2. Electrical Professional Engineer: Professional engineer possessing "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.
 3. Lighting Professional Engineer: Professional engineer possessing "Quality Requirements" and the following:
 - a. Expertise in electrical engineering, lighting design, and structural requirements for exterior poles and standards.
 - b. Lighting Certified (LC) Professional by the National Council on Qualifications for the Lighting Professions (NCQLP).
 4. Medium-Voltage Equipment Installer: Entity possessing "Quality Requirements" with documented training and experience with hazards and safety requirements associated with installation and operation of medium-voltage equipment in accordance with electrical utility service provider requirements.
 - a. Medium-voltage equipment Installer must be approved by Excel Energy.
 5. Electrical Power Monitoring Installers: Installer possessing "Quality Requirements," and able to present unexpired certified Installer credentials issued by manufacturer prior to starting installation.
 6. Generator Set Installers: Installer possessing Quality Requirements," and able to present unexpired certified Installer credentials issued by generator set manufacturer prior to starting installation.
 7. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - a. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.
 8. Medium-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - a. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

1.09 FIELD CONDITIONS

- A Modeling, analysis, product selection, installation, and quality control for Work specified in Division 26 must comply with requirements specified in Section 260011 "Facility Performance Requirements for Electrical."

PART 2 PRODUCTS

2.01 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

- A Substitution requests for electrical equipment will be entertained under the following conditions:
1. Notification of Contractor's intent to request substitutions for convenience must be declared during the Electrical Preconstruction Conference so potential risks to system performance and construction schedule may be identified for Contractor's response in submission of the substitution

request. Submission of requests for substitutions for convenience must meet the conditions and deadline.

2. For electrical equipment and systems, substitutions for cause are considered major construction risks. If it is possible that Contractor may need to request substitutions for cause because of equipment unavailability, or inability to meet construction schedule because of lead time, Contractor must declare the possibility during the Electrical Preconstruction Conference to permit establishing a mitigation plan for minimizing risks to system performance and construction schedule.

PART 3 EXECUTION

3.01 PREPARATION

- A Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:
1. Submission of power system studies.
 2. Submission of specified coordination drawings.
 3. Submission of action submittals specified in Division 26.
 4. Orders placed for major electrical equipment.
 5. Arrival of major electrical equipment on-site.
 6. Preinstallation meetings specified in Division 26.
 7. Utility service outages.
 8. Utility service inspection and activation.
 9. Mockup reviews.
 10. Closing of walls and ceilings containing electrical Work.
 11. System startup, testing, and commissioning activities for major electrical equipment.
 12. System startup, testing, and commissioning activities for emergency lighting.
 13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
 14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
 15. Requests for special inspections.
 16. Requests for inspections by authorities having jurisdiction.
- B Coordination Drawings for Structural Supports: Show coordination of structural supports for equipment and devices, including restraints and bracing for control of seismic and wind loads, with other systems, equipment, and structural supports in the vicinity.
- C Coordination Drawings for Ceiling Areas: Where indicated on Drawings, provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Structural members to which equipment, luminaires, and suspension systems will be attached.
 2. Size and location of access panels on ceilings.
 3. Elevation, size, and route of ductwork.
 4. Elevation, size, and route of conduit.
 5. Elevation and size of wall-mounted and ceiling-mounted equipment.
 6. Moldings.

7. Access panels.
 8. Sprinklers.
 9. Air inlets and outlets.
 10. Control modules.
 11. Luminaires.
 12. Communications devices.
 13. Fire-alarm devices.
 14. Indicate clear dimensions for maintenance access in front of equipment.
 15. Indicate dimensions of fully-open access doors.
- D Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- E Coordination Drawings for Large Equipment Indoor Installations:
1. Location plan, drawn to scale, showing heavy equipment or truck access paths to loading dock or other freight access into building. Indicate available width and height of doors or openings.
 2. Floor plan for entry floor and floor where equipment is located, drawn to scale, showing heavy equipment access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
 - a. Dimensioned concrete bases, outlines of equipment, conduit entries, and grounding equipment locations.
 - b. If freight elevator must be used, indicate width and height of door and depth of car. Indicate if large equipment must be tipped to use elevator.
 - c. Dimensioned working clearances and dedicated areas below and around electrical equipment where obstructions and tripping hazards are prohibited.
 3. Reflected ceiling plans for entry floor and floor where equipment is located, drawn to scale, on which the following items shown and coordinated with each other, based on input from installers of the items involved:
 - a. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways and seismic bracing.
 - b. Location of lighting fixtures, sprinkler piping and sprinklers, ducts and diffusers, and other obstructions, indicating available overhead clearance.
 - c. Dimensioned working clearances and dedicated areas above and around electrical equipment where foreign systems and equipment are prohibited.
- F Coordination Drawings for Large Equipment Outdoor Installations:
1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
 - a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
 - b. Indicate clear dimensions for fence gates and wall openings.
 - c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.

- d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.
 - e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways, busways.
 - f. Dimensioned working clearances and dedicated areas around electrical equipment.
- G Coordination Drawings for Duct Banks:
- 1. Show duct profiles and coordination with other utilities and underground structures.
 - 2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

3.02 DELEGATED DESIGN OF STRUCTURAL PENETRATIONS

- A Engage qualified structural professional engineer to design penetrations of structural masonry walls.
- B Delegated Design Drawings for Structural Masonry Wall Penetrations: Where indicated on Drawings, provide reflected ceiling plan(s), supplemented by elevations, sections, and other details, drawn to scale, signed and sealed by a qualified structural professional engineer, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
- 1. Location and dimensions of structural members supporting wall.
 - 2. Location and dimensions of columns near penetrations.
 - 3. Location and dimension of headers and lintels.
 - 4. Doors and windows near penetrations.
 - 5. Location and dimensions of penetrating cuts.
 - 6. Sprinkler piping and sleeves.
 - 7. Plumbing piping and sleeves.
 - 8. Ductwork and sleeves.
 - 9. Cable tray and sleeves.
 - 10. Conduit and sleeves.
 - 11. Firestopping assemblies for rated penetrations.
 - 12. Structural supports for piping, ductwork, and conduit on both sides of wall.
- C Delegated Design Criteria: As depicted on Drawings.

3.03 INSTALLATION OF ELECTRICAL WORK

- A Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Architect for resolution of conflicting requirements.

3.04 SYSTEM STARTUP

3.05 FIELD QUALITY CONTROL

- A Administrant for Medium-Voltage Electrical Tests and Inspections:
- 1. Will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
 - 2. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
- B Administrant for Low-Voltage Electrical Tests and Inspections:
- 1. Will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.

2. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
- C Administrant for Power-Limited Electrical Tests and Inspections:
1. Will engage qualified power-limited electrical testing and inspecting agency to administer and perform tests and inspections.
 2. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
- D Administrant for Structural Tests and Inspections:
1. Will engage qualified structural testing and inspecting agency to administer and perform tests and inspections.
 2. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
- E Administrant for Field Tests and Inspections of Lighting Installations:
1. Will engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
 2. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

3.06 CLEANING

3.07 CLOSEOUT ACTIVITIES

- A Operation and Maintenance Data: Prepare and submit the following:
1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device listed below:
 - a. Generator, ATS.
 2. Include the following information:
 - a. Manufacturer's operating specifications.
 - b. User's guides for software and hardware.
 - c. Schedule of maintenance material items recommended to be stored at Project site.
 - d. Detailed instructions covering operation under both normal and abnormal conditions.
 - e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
 - f. List of load-current and overload-relay heaters with related motor nameplate data.
 - g. List of lamp types and photoelectric relays used on Project, with ANSI and manufacturers' codes.
 - h. Manufacturer's instructions for setting field-adjustable components.
 - i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
 - j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
 - k. Exterior pole inspection and repair procedures.
 - l. Include copies of demonstration and training videos.
- B Software and Firmware Operational Documentation: Provide software and firmware operational documentation, including the following:
1. Software operating and upgrade manuals.

2. Names, versions, and website addresses for locations of installed software.
 3. Device address list.
 4. Printout of software application and graphic screens.
 5. Testing and adjusting of panic and emergency power features.
 6. For lighting controls, include the following:
 - a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
 - b. Operation of adjustable zone controls.
- C Software:
1. Program Software Backup: Provide USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
 2. Provide to Owner upgrades and unrestricted licenses for Government use for installed and backup software, including operating systems and programming tools required for operation and maintenance.
- D Demonstration: With assistance from factory-authorized service representatives, demonstrate to Owner's maintenance and clerical personnel how to operate the following systems and equipment:
1. Lighting control devices specified in Section 260923 "Lighting Control Devices."
 2. Electronic metering and billing software specified in Section 262713 "Electricity Metering."
- E Training: With assistance from factory-authorized service representatives, train Owner's maintenance personnel on the following topics:
1. How to implement Facility EPM Program.
 2. How to operate normal and emergency electrical systems, including justifications for, and limitations of, protective device settings recommended in study report specified in Section 260573.16 "Coordination Studies."
 3. Electrical power safety fundamentals refresher including arc-flash hazard safety features of electrical power distribution equipment in facility, interpreting arc-flash warning labels, selecting appropriate personal protective equipment, and understanding significance of findings documented in study report specified in Section 260573.19 "Arc-Flash Hazard Analysis."
 4. How to adjust, operate, and maintain systems specified in Section 260913 "Electrical Power Monitoring."
 5. How to adjust, operate, and maintain devices specified in Section 260923 "Lighting Control Devices."
 6. How to adjust, operate, and maintain equipment specified in Section 262300 "Low-Voltage Switchgear."
 7. How to adjust, operate, and maintain equipment specified in Section 262313 "Paralleling Low-Voltage Switchgear."
 8. How to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units specified in Section 262413 "Switchboards."
 9. How to adjust, operate, and maintain control modules specified in Section 262416.16 "Electronically Operated Circuit-Breaker Panelboards."
 10. How to adjust, operate, and maintain enclosed controllers specified in Section 262419 "Motor-Control Centers."
 11. How to adjust, operate, and maintain hardware and software specified in Section 262713 "Electricity Metering."

12. How to adjust, operate, and maintain equipment specified in Section 262913.06 "Soft-Start Motor Controllers."
13. How to adjust, operate, and maintain equipment specified in Section 262923 "Variable-Frequency Motor Controllers."
14. How to adjust, operate, and maintain controllers, remote alarm panels, and to use and reprogram microprocessor-based controls within this equipment specified in Section 262933 "Controllers for Fire Pump Drivers."
15. How to adjust, operate, and maintain equipment specified in Section 263213.13 "Diesel-Engine-Driven Generator Sets."
16. How to adjust, operate, and maintain equipment specified in Section 263213.16 "Gas-Engine-Driven Generator Sets."
17. How to adjust, operate, and maintain equipment specified in Section 263533 "Power Factor Correction Equipment."
18. How to adjust, operate, and maintain transfer switches and related equipment, including ground-fault protection system, specified in Section 263600 "Transfer Switches."

END OF SECTION 26 00 10

SECTION 26 00 11
SELECTIVE ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A Section 260500: Common Work Results for Electrical

1.02 SYSTEM DESCRIPTION

- A This Section includes all labor, material, equipment and services necessary and incidental to complete all the selective and or complete demolition and removal of electrical systems in the areas of remodeling or affected by remodeling, and the rework and extension of electrical systems indirectly affected by electrical system served "downstream" from the demolished electrical systems.
- B Coordinate with Mechanical Divisions 22 and 23 to ensure that equipment slated for demolition by those divisions are also coordinated with Division 26, 27 and 28. Perform complete demolition of all conduits, wiring, controls, starters, disconnects associated with Division 22 and 23 equipment demolition.
- C Coordinate demolition with the Owner's asbestos abatement contractor to ensure that all required demolition is included in the project. Any demolition work not included in the asbestos abatement contractor's work, but required for the project shall be included under this section by the Division 26 contractor. Coordinate work with the asbestos abatement contractor closely, especially where equipment or devices are noted on the plans to be reused or protected.

1.03 SUBMITTALS

- A Provide documentation of any and all hazardous waste being turned over to a certified hazardous waste disposal company in accordance with the Conditions of the Contract and Division 1 and 2 Specification Sections:
 - 1. Fluorescent Lamps
 - 2. Ballasts containing PCBs and DEHP

1.04 MATERIALS AND EQUIPMENT

- A Materials and equipment for patching and extending work: As specified in individual Division 26, 27 and 28 sections.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

- A Examine the building to determine actual conditions and extent of work prior to bidding the project. Refer any unclear details or conflicts to the Architect/Engineer for clarification prior to bidding the drawings.
- B Verify that field measurements and circuiting arrangements are as shown on Drawings.
- C Verify that abandoned wiring and equipment serve only abandoned facilities.
- D Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.
- E Perform preliminary on-site investigation(s) as required to ascertain extent of Work. Existing conditions which would have become apparent by such investigation(s) will not be allowed as cause for claims for extra cost.
- F Beginning of demolition means installer accepts existing conditions.

- G Contractor shall assume a limited amount of unforeseen conditions and shall provide the necessary work required for a complete and operating system.
- H Coordinate phasing of the demolition work with the construction sequence schedule.
- I Pre-demolition photographs or videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations. Submit before Work begins.
- J Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- K Coordinate utility service outages with Utility Company.
- L Identify and provide new supporting means for existing electrical equipment such as low voltage cabling, conduits, boxes, pullboxes, conduit bodies, and conduit racks that will need additional support due to the demolition of the existing supports, including ceilings, walls and structure above. Provide temporary shoring and supports if no existing structural members are available.
- M Erect, and maintain temporary safeguards, including warning signs and lights and barricades for protection of the public, Owner, Contractor's employees, and existing improvements to remain.
- N Maintain proper exit and egress paths through the building. Provide temporary emergency lighting and illuminated exit signage as required by the Building Official or AHJ.
- O Electrical Service: Maintain existing system throughout construction in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Notify and obtain permission from Owner, Architect/Engineer at least 24 hours before partially or disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- P Telephone, Data, Communications and Fire Alarm Systems: Cooperate and coordinate all demolition with Division 27 and 28 Contractors to maintain those existing systems throughout construction until new system(s) are complete and ready for service. Disable system only to make switchovers and connections. Notify and obtain permission from Owner, Architect/Engineer at least 24 hours before partially or disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- Q Conduct demolition to minimize interference with adjacent and occupied building areas.
- R Perform noisy work before or after the Owner's working hours to minimum disruption.
- S Coordinate and sequence demolition so as not to cause shutdown of operation of surrounding areas.
- T Any cutting method, which may create sparks, must include "Fire Watch" and portable fire-suppression devices as required by the Fire Code and/or the Owners Fire Insurance Carrier. Submit fire watch procedures for approval.
- U Draining operations must not damage building components.

3.02 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A Remove, reroute and/or extend any existing outlets, equipment, and associated branch circuit wiring and conduit systems that interfere with the new Work of the General Trades, Structural, Plumbing, Fire Protection, or HVAC Contractors.
- B Demolish electrical systems in walls, floors, and ceilings identified to be demolished.
- C Demolish and extend existing electrical work under and this Section or as indicated on the Drawings. Remove devices, conduit, wire, boxes, and fastening devices to avoid any interference with new installation.
- D Remove, relocate, and extend existing installations to accommodate new construction or to maintain systems downstream from demolished area.

- E Provide supports for all existing electrical equipment that was supported previously by demolished walls, floors, ceiling or other structures. Provide new supports from structural members not slated for demolition, prior to any demolition.
- F Disconnect and remove all items as shown and described on the drawings completely back to source, including:
 - 1. Lighting fixtures
 - 2. Electrical equipment
 - 3. Devices, boxes and plates
 - 4. Conduit and wires
 - 5. Associated disconnect(s), starters, controls, control wiring, indicators
- G Clear away debris, demolished material at frequent intervals. Do not allow debris to accumulate to extent it will interfere with Work or exit passageways.
- H Remove abandoned wiring to source of supply. Remove fuses and turn circuit breakers OFF.
- I Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit in existing concrete walls, floors, or columns back to a point where patching can be adequately performed and patch surfaces.
- J Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
- K Existing outlets which are to be removed and have conduits rising from the floor slab shall have the conduits cut below floor level. Rework as required to maintain service to downstream devices. Pull new wire between remaining outlets affected by feed-through. Patch floor as required to restore to original condition.
- L Disconnect and remove abandoned panelboards and distribution equipment.
- M Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- N Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.
- O Repair adjacent construction and finishes damaged during demolition and extension work.
- P Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- Q Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. Relocate and reroute conduit and wiring as required for conduit concealed in walls or structure being altered as part of the remodeling. Maintain continuity to all devices in and downstream of remodeled work.
- R Reroute existing raceway and wiring which is exposed due to removal of existing construction. Conceal new raceway and wiring and maintain operation.
- S If conductors are required to be removed from existing raceways, install with new conductors.
- T Provide new cover plates throughout the remodeled areas.
- U Dispose of fluorescent lamps, ballasts, and other hazardous materials in accordance with State and Federal regulations.
- V Provide threaded hubs and square headed plugs on both ends of evacuated conduits routed underfloor or underground. Provide thread sealing compound to render the installation watertight, even under moderate pressure.
- W Remove anchor bolts left behind from demolished electrical equipment. Grind down flush with floor.

- X Where removal of concrete housekeeping pads is indicated, remove concrete and reinforcing flush with floor and seal exposed concrete surfaces.

3.03 EXISTING PANELBOARDS

- A Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Reuse breakers if possible. Provide new breakers for new equipment unless breakers are specifically noted on the plans to be reused.
- B Tag unused circuits as "SPARE" and turn breakers and/or switches off.
- C Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area are not in use.
- D Remove existing wire no longer in use from panel to equipment.
- E Provide new updated directories where more than three circuits have been modified or rewired.
- F Provide conduit blanks in panels as necessary to cover any unused openings or knockouts.
- G Where existing panels are indicated to be demolished, extend any remaining live circuits to the nearest suitable panelboard. Remove busing in panelboards mounted flush in masonry walls and provide a finished blank steel plate installed over the panelboard cabinet to cover the entire opening.

3.04 CLEANING AND REPAIR

- A Prior to reinstallation of used equipment, thoroughly inspect each item and report any defects to the Engineer/Architect in writing. Instructions for corrective measures will be given at the time and the Contract amount adjusted accordingly. If no defects are reported, the material will be included under the contractor's one year guarantee.
- B Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C Luminaries: Where existing luminaries are indicated to be re-used, remove existing luminaries for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe metal parts dry. Air dry plastic lenses to prevent static electrical charge.
- D Replace non-functioning ballasts and broken electrical parts. Provide new lamps.
- E Repair adjacent construction and finishes damaged during demolition and extension work.

3.05 SALVAGE OF EQUIPMENT AND MATERIALS

- A Owner reserves the right of first refusal to obtain material shown to be removed under this contract. Items not retained by the Owner become the property of the Contractor and must be removed from the premises.
- B Clean, tag, and inventory all equipment and materials to be removed and turned over to the Owner. Turn inventory over to Owner and Engineer.
- C Protect equipment and materials to be turned over to the Owner and deliver to the location(s) on the site determined by the Owner.

3.06 INSTALLATION

- A Install relocated materials and equipment as indicated on the drawings.

END OF SECTION 26 00 11

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SUMMARY

A Section Includes:

1. Copper building wire.
2. Fire-alarm wire and cable.
3. Connectors and splices.

B Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.
4. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.02 ACTION SUBMITTALS

A Product Data:

1. Copper building wire.
2. Fire-alarm wire and cable.
3. Connectors and splices.

1.03 INFORMATIONAL SUBMITTALS

PART 2 PRODUCTS

2.01 COPPER BUILDING WIRE

A Manufacturers: Subject to compliance with requirements, undefined:

1. Southwire Company, LLC.

B Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

C Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B496 for stranded conductors.

E Conductor Insulation:

1. Type THHN and Type THWN-2. Comply with UL 83.
2. Type THW Type THW-2. Comply with NEMA WC-70/ICEA S-95-658 and UL 83.

2.02 FIRE-ALARM WIRE AND CABLE

A Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.

2. Cerro Wire LLC.
 3. Superior Essex Inc.; subsidiary of LS Corp.
 4. West Penn Wire; brand of Belden, Inc.
- B General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.
1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, 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.
- D Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.

2.03 CONNECTORS AND SPLICES

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 2. ILSCO.
 3. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
 4. TE Connectivity Ltd.
- 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 Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
1. Material: Copper.
 2. Type: One Two hole with standard barrels.
 3. Termination: Compression.

PART 3 EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A Feeders:
1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 2. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B Branch Circuits:
1. Copper:
 - a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 - b. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- C ASD Output Circuits Cable: Extra-flexible stranded for all sizes.
- D Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- E PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A Service Entrance: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.
- B Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- C Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.
- D Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- E Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.

3.03 INSTALLATION, GENERAL

- A Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B Complete raceway installation between conductor and cable termination points in accordance with Section 260533.13 "Conduits for Electrical Systems" prior to pulling conductors and cables.
- C Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.04 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A Comply with NFPA 72.
- B Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."
 - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
 - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
 - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
 - 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is not permitted.
 - 4. Signaling Line Circuits: Power-limited fire-alarm cables may be installed in the same cable or pathway as signaling line circuits.
- C Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

- D Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- E Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.
- F Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.
- G Wiring to Remote Alarm Transmitting Device: 1 inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.05 CONNECTIONS

- A Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.06 IDENTIFICATION

- A Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.07 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.08 FIRESTOPPING

- A Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Grounding and bonding conductors.
 - 2. Grounding and bonding clamps.
 - 3. Grounding and bonding bushings.
 - 4. Grounding and bonding hubs.
 - 5. Grounding and bonding connectors.
 - 6. Intersystem bonding bridge grounding connector.
 - 7. Grounding and bonding busbars.
 - 8. Signal reference grids.
 - 9. Grounding (earthing) electrodes.
 - 10. Grounding electrode enclosures.
- B Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.02 ACTION SUBMITTALS

- A Product Data: For each type of product.
- B Shop Drawings: Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding of Electrical Power" Article, including the following:
 - 1. Grounding electrode access enclosures.
 - 2. Grounding electrodes.
 - 3. Grounding arrangements and connections for separately derived systems.

1.03 CLOSEOUT SUBMITTALS

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING CONDUCTORS

- A Equipment Grounding Conductor:
 - 1. General Characteristics: 600 V, THHN/THWN-2 or THWN-2, copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B Isolated Equipment Grounding Conductor:
 - 1. General Characteristics: 600 V, THHN/THWN-2 or THWN-2, copper wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C ASTM - Bare Copper Grounding and Bonding Conductor:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ERICO; brand of nVent Electrical plc.
 - b. Harger Lightning & Grounding; business of Harger, Inc.

2. Referenced Standards: Complying with one or more of the following:
 - a. Soft or Annealed Copper Wire: ASTM B3.
 - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
 - c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
 - d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

2.02 GROUNDING AND BONDING CLAMPS

- A Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.
- B Performance Criteria:
1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- C UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. ERICO; brand of nVent Electrical plc.
 - c. Harger Lightning & Grounding; business of Harger, Inc.
 2. General Characteristics:
 - a. Two pieces with stainless steel bolts.
 - b. Clamp Material: Brass.
 - c. Listed for outdoor use.
- D UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. ERICO; brand of nVent Electrical plc.
 - c. Harger Lightning & Grounding; business of Harger, Inc.
 2. General Characteristics:
 - a. Clamp Material: Brass.
 - b. Listed for outdoor use.
- E UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - c. ERICO; brand of nVent Electrical plc.
 2. General Characteristics:
 - a. Clamp Material: Copper.
 - b. Listed for outdoor use.

- F UL KDER - Beam Grounding and Bonding Clamp:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - 2. General Characteristics: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.
- G UL KDER - Exothermically Welded Connection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - c. ERICO; brand of nVent Electrical plc.
 - d. Harger Lightning & Grounding; business of Harger, Inc.
 - 2. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.03 GROUNDING AND BONDING BUSHINGS

- A Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.
- B Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- C UL KDER - Bonding Bushing:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - 2. General Characteristics: Threaded bushing with insulated throat.
- D UL KDER - Grounding Bushing:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - 2. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.04 GROUNDING AND BONDING CONNECTORS

- A Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- B UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - 2. General Characteristics: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.
- C UL KDER - Crimped Lug Pressure-Type Grounding and Bonding Busbar Terminal:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. ILSCO.
 - 2. General Characteristics: Cast silicon bronze, solderless compression-type wire terminals; with long barrel and two holes spaced on 5/8 or 1 inch centers for two-bolt connection to busbar.
- D UL KDER - Split-Bolt Service-Post Pressure-Type Grounding and Bonding Busbar Terminal:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - 2. General Characteristics: Bolts that surround cable and bond to cable under compression when nut is tightened after assembly is screwed into busbar opening.
- E UL KDER - Crimped Pressure-Type Grounding and Bonding Cable Connector:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. ILSCO.
 - 2. General Characteristics: Crimp-and-compress connectors that bond to conductor when connector is compressed around conductor.
 - a. Copper, C and H shaped.
- F UL KDER - Split-Bolt Pressure-Type Grounding and Bonding Cable Connector:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. ERICO; brand of nVent Electrical plc.
 - 2. General Characteristics: Bolts that surround cable and bond to cable under compression when nut is tightened.
 - a. Copper.

2.05 GROUNDING (EARTHING) ELECTRODES

- A Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- B UL KDER - Rod Electrode:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. ERICO; brand of nVent Electrical plc.
 - c. Harger Lightning & Grounding; business of Harger, Inc.
 - 2. General Characteristics: Copper-clad steel; 3/4 inch by 10 ft.

PART 3 EXECUTION

3.01 EXAMINATION

- A Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B Inspect test results of grounding system measured at point of electrical service equipment connection.
- C Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.02 SELECTION OF GROUNDING AND BONDING PRODUCTS

- A Grounding and Bonding Conductors:
 - 1. Provide solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
 - 2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
 - 3. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch in diameter.
 - 4. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
 - 6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
 - 7. Underground Grounding Conductors: Install bare copper conductor, 2/0 AWG minimum.
- B Grounding and Bonding Connectors:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- C Grounding and Bonding Busbars: Provide in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on Drawings.

D Substation Signal Reference Grid:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with IEEE C2.
 - a. Install 6 AWG bonding conductors below grade in a grid pattern on 2 ft centers. Bond grid conductors with exothermic welds where they cross each other.
 - b. Grid must fill entire area inside equipment yard fence, and extend minimum 6.5 ft outside fence, so someone walking or running outside yard may not touch fence or open gate without first stepping inside grid.
 - c. Bond each metal fence post and gate post to at least two grid conductors.
 - d. Inside grid, bond equipment reinforcing steel inside bases and sidewalks to at least two grid conductors.
 - e. Bond underground metal pipe and conduit passing under grid to nearest grid conductor at both ends.

E Signal Reference Grid Tape Mesh:

1. Install tape mesh under floor finish with the following features:
 - a. Tape mesh, 2 inch by 16 mil solid copper, 12 inch spacing.

3.03 INSTALLATION OF GROUNDING AND BONDING

A Comply with manufacturer's published instructions.

B Reference Standards:

1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
2. Consult Architect for resolution of conflicting requirements.

C Special Techniques:

1. Grounding and Bonding Conductors:
 - a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
 - b. Underground Grounding Conductors:
 - 1) Bury at least 30 inches below grade.
2. Grounding and Bonding Connectors: 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.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - f. 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 adjacent parts.
 - 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.
- g. Grounding and Bonding for Piping:
- 1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
 - 3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- h. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft apart.
3. Grounding and Bonding Busbars:
- a. Install busbar horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.
 - b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.
4. Electrodes:
- a. Ground Rods: Drive rods until tops are 2 inch below finished floor or final grade unless otherwise indicated.
 - 1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2) Use exothermic welds for below-grade connections.
 - b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
 - c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch deep, with cover.
 - 1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
 - d. Ring Electrode: Install grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around perimeter of building.
 - 1) Install tinned-copper conductor not less than 2/0 AWG for ring electrode and for taps to building steel.
 - 2) Bury ring electrode not less than 24 inches from building's foundation.

- e. Concrete-Encased Electrode (Ufer Ground):
 - 1) Fabricate in accordance with NFPA 70; use minimum of 20 ft of bare copper conductor not smaller than 4 AWG.
 - a) If concrete foundation is less than 20 ft long, coil excess conductor within base of foundation.
 - b) Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
 - 2) Fabricate in accordance with NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 ft long. If reinforcing is in multiple pieces, connect together by usual steel tie wires or exothermic welding to create required length.
- 5. Grounding at Service:
 - a. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.
- 6. Grounding Separately Derived Systems:
 - a. Permanent Generators: Install grounding electrode(s) at location of permanent generators having switched neutral connections. Electrode must be connected to equipment grounding conductor and to frame of generator.
- 7. Grounding Underground Distribution System Components:
 - a. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.
 - b. Comply with IEEE C2 grounding requirements.
 - c. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than 6 inches from foundation.
- 8. Equipment Grounding and Bonding:
 - a. Install insulated equipment grounding conductors with feeders and branch circuits.
 - b. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
 - c. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
 - d. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.

9. Fence Grounding:
 - a. Grounding Method: At each grounding location, drive grounding rod vertically until top is 6 inch below finished grade. Connect rod to fence with 6 AWG conductor. Connect conductor to each fence component at grounding location.
 - b. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of power line crossing and at maximum distance of 150 ft on each side of crossing.
 - c. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground fence and bond fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.04 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

- A Field tests and inspections must be witnessed by authorities having jurisdiction.
- B Tests and Inspections:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
 3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
 - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C Nonconforming Work:
 1. Grounding system will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective components and retest.
- D Collect, assemble, and submit test and inspection reports.
 1. Report measured ground resistances that exceed the following values:
 - a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 5 ohms.

3.05 PROTECTION

- A After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 26

INTENTIONALLY LEFT BLANK

SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Support, anchorage, and attachment components.
- B Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.02 ACTION SUBMITTALS

- A Product Data:
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.

1.03 INFORMATIONAL SUBMITTALS

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Allied Tube & Conduit; Atkore International.
 - c. Atkore Unistrut.
 - d. CADDY; brand of nVent Electrical plc.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 4. Channel Width: 1-5/8 inch.
 - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- B Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Atkore Unistrut.
 - c. Flex-Strut Inc.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Channel Material: 6063-T5 aluminum alloy.
 - 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 - 5. Channel Width: 1-5/8 inch.
 - 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C Conduit and Cable Support Devices: Steel Glass-fiber-resin hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.
- E Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
 - 6. Toggle Bolts: All steel springhead type.

7. Hanger Rods: Threaded steel.

PART 3 EXECUTION

3.01 SELECTION

- A Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA NEIS 101
 2. NECA NEIS 102.
- B Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."
- D Comply with requirements for boxes specified in Section 260533.16 "Boxes and Covers for Electrical Systems."
- E Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be 1/4 inch in diameter.
- F Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps single-bolt conduit clamps using spring friction action for retention in support channel.

3.02 INSTALLATION OF SUPPORTS

- A Comply with NECA NEIS 101 for installation requirements except as specified in this article.
- B Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT may be supported by openings through structure members, in accordance with NFPA 70.
- C 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 must be weight of supported components plus 200 lb.
- D Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Spring-tension clamps.
 7. To Light Steel: Sheet metal screws.

- 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panel-boards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A Comply with installation requirements in Section 055000 "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. Submit welding certificates.

3.04 PAINTING

- A Touchup:
 - 1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 29

SECTION 26 05 33.13

CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Type PVC duct raceways and fittings.
- B Products Installed, but Not Furnished, under This Section:
 - 1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.
- C Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
 - 3. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).
 - 4. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

1.02 DEFINITIONS

- A Conduit: A structure containing one or more duct raceways.
- B Duct Raceway: A single enclosed raceway for conductors or cable.
- C Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.

1.03 ACTION SUBMITTALS

- A Product Data:
 - 1. Type PVC duct raceways and fittings.

1.04 INFORMATIONAL SUBMITTALS

- A Manufacturers' Published Instructions:
 - 1. Type PVC duct raceways and fittings.

PART 2 PRODUCTS

2.01 TYPE PVC DUCT RACEWAYS AND FITTINGS

- A Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria: UL CCN DZYR; including UL 651.
- B Source Quality Control:
 - 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
 - 2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

- C UL DZXR - Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Calconduit; Atkore International.
 - c. National Pipe and Plastic, Inc. (Oldcastle).
 - 2. Dimensional Specifications: Schedule 80.
 - 3. Options:
 - a. Minimum Trade Size: [Metric designator 16 (trade size 1/2)].
 - b. Markings: [For use with maximum 90 deg C wire] [For directional boring applications].

PART 3 EXECUTION

3.01 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.
- B Special Instructions Regarding HDPE Conduits: Although Article 353 of NFPA 70 permits use of HDPE conduits where encased in concrete aboveground, UL CCN EAZX listing requirements state that HDPE [and EPEC] underground conduits are intended only for use where direct buried with or without being encased in concrete. Specified Type HDPE and Type EPEC underground conduits are not permitted to be used aboveground on Project.
- C Outdoors:
 - 1. Exposed and Subject to Severe Physical Damage.
 - 2. Exposed and Subject to Physical Damage: Corrosion-resistant EMT.
 - a. Locations less than 2.5 m (8 ft) above finished floor.
 - 3. Exposed and Not Subject to Physical Damage: Corrosion-resistant EMT PVC-80.
 - 4. Concealed Aboveground: EMT PVC-80.
 - 5. Direct Buried: PVC-80.
 - 6. Concrete Encased Not in Trench: PVC-80.
 - 7. Concrete Encased in Trench: PVC-80.
 - 8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
- D Indoors:
 - 1. Exposed and Subject to Severe Physical Damage: ERM. Locations include the following:
 - a. Loading docks.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
 - 2. Exposed and Subject to Physical Damage: ERM. Locations include the following:
 - a. Locations less than 2.5 m (8 ft) above finished floor.
 - b. Stub-ups to above suspended ceilings.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 4. Damp or Wet Locations: Corrosion-resistant EMT.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

- E Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
 - 1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

3.02 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A Comply with manufacturer's published instructions.
- B Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 - 1. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
 - 2. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.
 - 3. Expansion Fittings: NEMA FB 2.40.
 - 4. Consult Architect for resolution of conflicting requirements.
- C Special Installation Techniques:
 - 1. General Requirements for Installation of Duct Raceways:
 - a. Complete duct raceway installation before starting conductor installation.
 - b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.
 - c. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch of changes in direction.
 - d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
 - e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
 - f. Support conduit within 12 inch of enclosures to which attached.
 - g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
 - h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:
 - 1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2) Where an underground service duct raceway enters a building or structure.
 - 3) Conduit extending from interior to exterior of building.
 - 4) Conduit extending into pressurized duct raceway 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.
 - i. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
 - j. Do not install conduits within 2 inch of the bottom side of a metal deck roof.

- k. Keep duct raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
 - l. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
 - m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb. tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
 - n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
 - 1) Termination fittings with shoulders do not require two locknuts.
 - o. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- 2. Types EMT-A, ERMC-A, and FMC-A: Do not install aluminum duct raceways or fittings in contact with concrete or earth.
 - 3. Types ERMC and IMC:
 - a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.
 - 4. Type ERMC-S-PVC:
 - a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
 - b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-S-PVC duct raceway.
 - c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.
 - 5. Types FMC, LFMC, and LFNC:
 - a. Provide a maximum of 36 inch of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 6. Types PVC, HDPE, and EPEC:
 - a. Do not install Type PVC, Type HDPE, or Type EPEC conduit where ambient temperature exceeds 122 deg F. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
 - b. Comply with manufacturer's published instructions for solvent welding and fittings.

7. Type RTRC: Do not install Type RTRC conduit where ambient temperature exceeds 230 deg F.
8. Duct Raceways Embedded in Slabs:
 - a. [Run duct raceways larger than metric designator 27 (trade size 1) below concrete slab] [Run duct raceways larger than metric designator 27 (trade size 1) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place duct raceway close to slab support. Secure duct raceways to reinforcement at maximum 10 ft intervals].
 - b. Arrange duct raceways to cross building expansion joints with expansion fittings at right angles to the joint.
 - c. Arrange duct raceways to ensure that each is surrounded by minimum of 2 inch of concrete without voids.
 - d. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.
 - e. Change from ENT to ERM or IMC before rising above floor.
9. Stub-ups to Above Recessed Ceilings:
 - a. Provide EMT, IMC, or ERM for duct raceways.
 - b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
10. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:
 - a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG. Install insulated throat metal grounding bushings on service conduits.
11. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
 - a. ERM-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - b. EMT: Provide compression, cast-metal fittings. Comply with NEMA FB 2.10.
 - c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.
12. Expansion-Joint Fittings:
 - a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft. Install in runs of aboveground ERM and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft.
 - b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
 - 1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - 2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - 3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - 4) Attics: temperature change.
 - c. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.00078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

- d. Install expansion fittings at locations where conduits cross building or structure expansion joints.
 - e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
13. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.
14. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.
- a. Provide warning signs.
- D Interfaces with Other Work:
- 1. Coordinate installation of new products for with existing conditions.
 - 2. Coordinate with Section 078413 "Penetration Firestopping" for installation of firestopping at penetrations of fire-rated floor and wall assemblies.
 - 3. Coordinate with Section 260529 "Hangers and Supports for Electrical Systems" for installation of conduit hangers and supports.

3.03 PROTECTION

- A Protect coatings, finishes, and cabinets from damage and deterioration.
- 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33.13

SECTION 26 05 33.16
BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Metallic outlet boxes, device boxes, rings, and covers.
 - 2. Nonmetallic outlet boxes, device boxes, rings, and covers.
 - 3. Junction boxes and pull boxes.
 - 4. Cover plates for device boxes.
 - 5. Hoods for outlet boxes.
- B Products Installed, but Not Furnished, under This Section:
 - 1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.
- C Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.02 ACTION SUBMITTALS

- A Product Data:
 - 1. Metallic outlet boxes, device boxes, rings, and covers.
 - 2. Nonmetallic outlet boxes, device boxes, rings, and covers.
 - 3. Junction boxes and pull boxes.
 - 4. Cover plates for device boxes.
 - 5. Hoods for outlet boxes.
- B Shop Drawings:
 - 1. Shop drawings for floor boxes.

1.03 INFORMATIONAL SUBMITTALS

PART 2 PRODUCTS

2.01 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

- A UL QCIT - Metallic Outlet Boxes and Covers:
 - 1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - b. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
 - d. Pass & Seymour; Legrand North America, LLC.
 - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - f. Wiremold; Legrand North America, LLC.

3. Options:
 - a. Material: Sheet steel.
 - b. Sheet Metal Depth: Minimum 1.5 inch.
 - c. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb.
 - d. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb.
- B UL QCIT - Metallic Conduit Bodies:
 1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - b. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
 - c. Pass & Seymour; Legrand North America, LLC.
- C UL QCIT - Metallic Device Boxes:
 1. Description: Box with provisions for mounting wiring device directly to box.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
 - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 3. Options:
 - a. Material: Sheet steel.
 - b. Sheet Metal Depth: minimum 1.5 inch.
- D UL QCIT - Metallic Extension Rings:
 1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - c. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - d. Pass & Seymour; Legrand North America, LLC.
 - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
- E UL QCIT - Metallic Floor Boxes and Floor Box Covers:
 1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

- c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour; Legrand North America, LLC.
 - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - f. Wiremold; Legrand North America, LLC.
- F UL QCIT - Metallic Raised-Floor Boxes and Floor Box Covers:
- 1. Description: Box mounted in raised-floor with floor box cover and other components to complete floor box enclosure.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - b. Wiremold; Legrand North America, LLC.
- G UL QCIT - Metallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:
- 1. Description: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - b. Wiremold; Legrand North America, LLC.
- H UL QCIT - Metallic Concrete Boxes and Covers:
- 1. Description: Box intended for use in poured concrete.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - b. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Wiremold; Legrand North America, LLC.

2.02 JUNCTION BOXES AND PULL BOXES

- A UL BGUZ - Indoor Sheet Metal Junction and Pull Boxes:
- 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Appleton; Emerson Electric Co., Automation Solutions.
 - b. Hoffman; brand of nVent Electrical plc.
 - c. Milbank Manufacturing Company.
 - d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
 - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - 3. Options:
 - a. Degree of Protection: Type 1.
- B UL BGUZ - Outdoor Sheet Metal Junction and Pull Boxes:
- 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hoffman; brand of nVent Electrical plc.

- b. Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - d. Milbank Manufacturing Company.
 - e. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
 - f. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - g. Square D; Schneider Electric USA.
3. Options:
- a. Degree of Protection: Type 3R.

2.03 COVER PLATES FOR DEVICES BOXES

- A Performance Criteria:
- 1. Wallplate-Securing Screws: Metal with head color to match wallplate finish.
- B UL QCIT or QCMZ - Metallic Cover Plates for Device Boxes:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - b. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - d. Leviton Manufacturing Co., Inc.
 - e. Pass & Seymour; Legrand North America, LLC.
 - f. Wiremold; Legrand North America, LLC.
 - 2. Options:
 - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
 - b. Wallplate Material: 0.040 inch thick aluminum, anodized or lacquered to prevent corrosion Galvanized steel.

2.04 HOODS FOR OUTLET BOXES

- A Performance Criteria:
- 1. Listing Criteria:
 - a. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
 - 2. Mounts to box using fasteners different from wiring device.
- B Source Quality Control:
- 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
 - 2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
- C UL QCIT or QCMZ - Extra-Duty, While-in-Use Hoods for Outlet Boxes:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arlington Industries, Inc.
 - b. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - c. Intermatic, Inc.
 - d. Leviton Manufacturing Co., Inc.
 - 2. Additional Characteristics: Marked "Extra-Duty" in accordance with UL 514D.

3. Options:
 - a. Provides clear, weatherproof, "while-in-use" cover.
 - b. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

PART 3 EXECUTION

3.01 PREPARATION

- A Shop Drawings: Prepare and submit the following:
 1. Shop Drawings for Floor Boxes: Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness at location where boxes are embedded in concrete floors and underfloor clearances where boxes are installed in raised floors.

3.02 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.
- B Degree of Protection:
 1. Outdoors:
 - a. Type 3R unless otherwise indicated.
 2. Indoors:
 - a. Type 1 unless otherwise indicated.
 - b. Damp or Dusty Locations: Type 4.
 - c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
- C Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:
 1. Boxes with knockouts or unprotected openings are prohibited.
 2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.03 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A Comply with manufacturer's published instructions.
- B Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 1. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
 2. Consult Architect for resolution of conflicting requirements.
- C Special Installation Techniques:
 1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
 2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
 3. 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, whether installed indoors or outdoors.
 4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
 5. Locate boxes so that cover or plate will not span different building finishes.
 6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.

7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
 8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
 9. Set metal floor boxes level and flush with finished floor surface.
 10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
 11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
 12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
 13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
 - a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
 - b. Provide gaskets for wallplates and covers.
 14. Identification: Provide labels for boxes and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Provide warning signs.
 - c. Label each box with engraved metal or laminated-plastic nameplate.
- D Interfaces with Other Work:
1. Coordinate installation of new products for with existing conditions.
 2. Coordinate with Section 260573.13 "Short-Circuit Studies" for determining available fault current on input feeder.
 3. Coordinate with Section 260573.19 "Arc-Flash Hazard Analysis" for determining arc-flash hazard on input feeder.

3.04 CLEANING

- A Remove construction dust and debris from boxes before installing wallplates, covers, and hoods.

3.05 PROTECTION

- A After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 33.16

SECTION 26 05 44

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Round sleeves.
 - 2. Rectangular sleeves.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.
 - 6. Pourable sealants.
 - 7. Foam sealants.
- B Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.02 ACTION SUBMITTALS

- A Product Data: For each type of product.

PART 2 PRODUCTS

2.01 ROUND SLEEVES

- A Steel Wall Sleeves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. Flexicraft Industries.
 - c. GPT; a division of EnPRO Industries.
 - 2. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.
- B PVC Pipe Sleeves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. GPT; a division of EnPRO Industries.
 - b. Metraflex Company (The).
 - 2. General Characteristics: ASTM D1785, Schedule 40.
- C PVC Molded Sleeves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Arlington Industries, Inc.
 - c. Reliance Worldwide Corporation.
 - d. Roxtec Inc.

2. General Characteristics: With nailing flange for attaching to wooden forms.
- D Round, Galvanized-Steel, Sheet Metal Sleeves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Benefast.
 - b. Specified Technologies Inc.
 2. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.02 RECTANGULAR SLEEVES

- A Rectangular, Galvanized-Steel, Sheet Metal Sleeves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Abesco Fire LLC.
 - b. Roxtec Inc.
 - c. Specified Technologies Inc.
 - d. Wiremold; Legrand North America, LLC.
 2. General Characteristics:
 - a. Material: Galvanized sheet steel.
 - b. Minimum Metal Thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inch and with no side larger than 16 inch, thickness must be 0.052 inch.
 - 2) For sleeve cross-section rectangle perimeter not less than 50 inch or with one or more sides larger than 16 inch, thickness must be 0.138 inch.

2.03 SLEEVE-SEAL SYSTEMS

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, LLC.
 2. CALPICO, Inc.
 3. Flexicraft Industries.
 4. Proco Products, Inc.
- B General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
- C Options:
1. Sealing Elements: EPDM Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Fiber-reinforced plastic.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.04 SLEEVE-SEAL FITTINGS

- A Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Holdrite; a division of Reliance Worldwide Corporation.
- B General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.05 GROUT

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Specified Technologies Inc.
 - 2. W. R. Meadows, Inc.
- B General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
 - 1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 - 2. Design Mix: 5000 psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.06 POURABLE SEALANTS

- A Performance Criteria:
 - 1. General Characteristics: Single-component, neutral-curing elastomeric sealants of grade indicated below.
 - a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.07 FOAM SEALANTS

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Innovative Chemical Products (Building Solutions Group).
 - 2. The Dow Chemical Company.
- B Performance Criteria:
 - 1. General Characteristics: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 EXECUTION

3.01 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch above finished floor level. Install sleeves during erection of floors.
- B Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- C Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- D Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- E Underground, Exterior-Wall and Floor Penetrations:
 1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.
 2. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

3.02 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

- A Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
- B Install conduits and cable with no crossings within the sleeve.
- C Fill opening around conduits and cables with expanding foam without leaving voids.
- D Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.03 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 26 05 44

SECTION 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A Section Includes:

1. Labels.
2. Extruded insulating tubing.
3. Bands.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.

B Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.02 ACTION SUBMITTALS

A Product Data: For each type of product.

PART 2 PRODUCTS

2.01 LABELS

A Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B UL PGDQ2 - Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Panduit Corp.

2.02 EXTRUDED INSULATING TUBING

A Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN YDPU2 for components; including UL 224.

B UL YDPU2 - Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Panduit Corp.

2.03 BANDS

- A Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Panduit Corp.
 - c. Seton Identification Products; a Brady Corporation company.
- B Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch long, with diameters sized to suit diameters and that stay in place by gripping action.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. HellermannTyton.
 - c. Panduit Corp.

2.04 TAPES AND STENCILS

- A Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. Panduit Corp.
- B Underground-Line Warning Tape:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Ideal Industries, Inc.
 - c. Seton Identification Products; a Brady Corporation company.
 - 2. Tape:
 - a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape must be permanent and may not be damaged by burial operations.
 - c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 3. Color and Printing:
 - a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
 - b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW" .
 - 4. Nonconducting Line-Warning Tape :
 - a. Pigmented polyolefin, bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
 - b. Width: 3 inch.
 - c. Thickness: 4 mil.
 - d. Weight: 18.5 lb/1000 sq. ft.
 - e. Tensile in accordance with ASTM D882: 30 lbf and 2500 psi.
 - 5. Detectable Line-Warning Tape :
 - a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
 - b. Width: 3 inch.
 - c. Overall Thickness: 5 mil.

- d. Foil Core Thickness: 0.35 mil.
- e. Weight: 28 lb/1000 sq. ft.
- f. Tensile in accordance with ASTM D882: 70 lbf and 4600 psi.

2.05 TAGS

- A Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. Panduit Corp.

2.06 SIGNS

- A Laminated Acrylic or Melamine Plastic Signs:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Brady Corporation.
 - 2. Engraved legend.
 - 3. Thickness:
 - a. For signs up to 20 sq. inch, minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. inch, 1/8 inch thick.
 - c. Engraved legend with black letters on white face .
 - d. Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.07 CABLE TIES

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ideal Industries, Inc.
 - 2. Marking Services Inc.
 - 3. Panduit Corp.
- B Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria: UL CCN ZODZ; including UL 1565 or UL 62275.
- C UL ZODZ - General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.
- D UL ZODZ - Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F in accordance with ASTM D638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

PART 3 EXECUTION

3.01 PREPARATION

- A Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.02 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

- A Comply with 29 CFR 1910.144 for color identification of hazards, and the following:
 - 1. Fire-protection and fire-alarm equipment , including raceways, must be finished, painted, or suitably marked safety red.
 - 2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft above finished floor.
- B Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.
 - 1. Color must be factory applied or field applied for sizes larger than 6 AWG when permitted by authorities having jurisdiction.
 - 2. Colors for 208Y/120 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 240 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - 4. Colors for 480Y/277 V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 5. Color for Neutral (Grounded Conductor): White .
 - 6. Color for Equipment Ground: Green .
 - 7. Color for Isolated Ground: Green with two or more yellow stripes.
- C Color-Coding Raceways, Cable Trays, Junction Boxes, and Conductors for Intrinsically-Safe Circuits: Light blue. When used to identify intrinsically-safe circuits, Article 504 of NFPA 70 requires that the color light blue not be used for any other purpose.
- D Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.
- E Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- F Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- G Locations of Underground Lines: Underground-line warning tape for power and lighting.
- H Vaults, Manholes, Handholes, and Pull and Junction Boxes, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation.

- I Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3 inch high, black letters on 20 inch centers.
1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10 ft maximum intervals.
 2. Identify system voltage and system or service type with black letters on orange field.
 3. Apply floor marking tape to the following finished surfaces:
 - a. Floor surface directly above conduits running beneath and within 12 inch of floor that is in contact with earth or is framed above unexcavated space.
 - b. Wall surfaces directly external to raceways concealed within wall.
 - c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.
- J Conductors to Be Extended in Future: Attach marker tape to conductors.
- K Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:
1. Panelboard designation.
 2. Colon or dash.
 3. Branch circuit number.
- L Workspace Indication: Apply floor marking tape and stencil to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- M Equipment Identification Labels:
1. Black letters on white field.
 2. Indoor Equipment: Laminated acrylic or melamine plastic sign.
 3. Outdoor Equipment: Laminated acrylic or melamine sign Stenciled legend 4 inch high.
 4. Equipment to Be Labeled:
 - a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
 - b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of self-adhesive, engraved, laminated acrylic or melamine label.
 - c. Enclosures and electrical cabinets.
 - d. Access doors and panels for concealed electrical items.
 - e. Switchgear.
 - f. Switchboards.
 - g. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
 - h. Emergency system boxes and enclosures.
 - i. Enclosed switches.
 - j. Enclosed circuit breakers.
 - k. Enclosed controllers.
 - l. Variable-speed controllers.
 - m. Push-button stations.
 - n. Power-transfer equipment.
 - o. Contactors.
 - p. Remote-controlled switches, dimmer modules, and control devices.

q. .

N Cable Ties: General purpose, for attaching tags, except as listed below:

1. In Spaces Handling Environmental Air: Plenum rated.

3.03 SELECTION OF SIGNS AND HAZARD MARKINGS

A Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

B Electrical Hazard Warnings:

1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with and requirements for arc-flash hazard warning labels.
2. Raceways and Cables Carrying Circuits at More Than 1000 V:
 - a. Black letters on orange field.
 - b. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
3. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
4. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

C Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels .

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.

3.04 SELECTION OF IDENTIFICATION PRODUCTS FOR COMMUNICATIONS, CONTROL, AUXILIARY, AND LIFE SAFETY SYSTEMS

A Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.05 INSTALLATION

A Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

C Install identifying devices before installing acoustical ceilings and similar concealment.

- D Verify identity of item before installing identification products.
- E Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- F Apply identification devices to surfaces that require finish after completing finish work.
- G Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- H Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.
- I Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.
- J Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.
- K Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.
- L Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.
- M Marker Tapes: Secure tight to surface at location with high visibility and accessibility.
- N Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape not less than 12 inch directly above cables or raceways buried 18 inch or more below grade. Use multiple tapes where width of multiple lines installed in common trench or concrete envelope exceeds 16 inch overall.
 - 2. Limit use of underground-line warning tape to direct-buried cables.
 - 3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- O Nonmetallic Preprinted Tags:
 - 1. Place in location with high visibility and accessibility.
 - 2. Secure using general-purpose plenum-rated cable ties.
- P Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 26 05 53

INTENTIONALLY LEFT BLANK

SECTION 26 05 73.1 SHORT-CIRCUIT STUDIES

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Computer-based, fault-current study to determine minimum interrupting capacity of circuit protective devices.
- B Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
 - 3. Section 260573.16 "Coordination Studies" for overcurrent protective device coordination studies.
 - 4. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.02 DEFINITIONS

- A Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items must remain functional throughout construction period.
- B One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- D SCCR: Short-circuit current rating.
- E Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- F Single-Line Diagram: See "One-Line Diagram."

1.03 ACTION SUBMITTALS

- A Product Data:
 - 1. For power system analysis software to be used for studies.
- B Short-Circuit Study Report:
 - 1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form.
 - a. Short-circuit study input data, including completed computer program input data sheets.
 - b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
 - c. Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.04 INFORMATIONAL SUBMITTALS

- A Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.05 QUALITY ASSURANCE

- A Study must be performed using commercially developed and distributed software designed specifically for power system analysis.

PART 2 PRODUCTS

2.01 POWER SYSTEM ANALYSIS SOFTWARE

- A Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. SKM Systems Analysis, Inc.
- B Comply with IEEE 399 and IEEE 551.
- C Analytical features of power systems analysis software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output.
- E Computer program must be designed to perform short-circuit studies or have function, component, or add-on module designed to perform short-circuit studies.
- F Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.02 SHORT-CIRCUIT 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 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 study.
- D Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.
- E Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand 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 short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F Short-Circuit Study Input Data:
1. One-line diagram of system being studied.
 2. Power sources available.
 3. Manufacturer, model, and interrupting rating of protective devices.
 4. Conductors.
 5. Transformer data.
- 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.

PART 3 EXECUTION

3.01 POWER SYSTEM DATA

- A Obtain data necessary for conduct of study.
1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.
 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
 3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.
- B Gather and tabulate required input data to support short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are 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. Obtain electrical power utility impedance at service.
 3. Power sources and ties.
 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.

7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or non-magnetic).
11. Derating factors.

3.02 SHORT-CIRCUIT STUDY

- A Perform study following general study procedures contained in IEEE 399.
- B Calculate short-circuit currents according to IEEE 551.
- C Base study on device characteristics supplied by device manufacturer.
- D Extent of electrical power system to be studied is indicated on Drawings.
- E Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 5 kA or less.
 2. Exclude equipment supplied by single transformer smaller than 75 kVA.
- F Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G Include 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 fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- H Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.
 1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.
- I Include in report identification of protective device applied outside its capacity.

END OF SECTION 26 05 73.13

SECTION 26 05 73.16 COORDINATION STUDIES

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
 - a. Study results must be used to determine coordination of series-rated devices.
- B Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
 - 3. Section 260573.13 "Short-Circuit Studies" for fault-current studies.
 - 4. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.02 DEFINITIONS

- A Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items must remain functional throughout construction period.
- B One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of electric circuit or system of circuits and the component devices or parts used therein.
- C Protective Device: A device that senses when abnormal current flow exists and then removes the affected portion of the circuit from the system.
- D SCCR: Short-circuit current rating.
- E Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- F Single-Line Diagram: See "One-Line Diagram."

1.03 ACTION SUBMITTALS

- A Product Data:
 - 1. For power system analysis software to be used for studies.
- B Coordination Study Report:
 - 1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form.
 - a. Coordination-study input data, including completed computer program input data sheets.
 - b. Study and equipment evaluation reports.
 - c. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
 - d. Revised one-line diagram, reflecting field investigation results and results of coordination study.

1.04 INFORMATIONAL SUBMITTALS

- A Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.05 QUALITY ASSURANCE

- A Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.
- B Manual calculations are unacceptable.

1.06 REGULATORY AGENCY APPROVALS

- A Submittals for coordination study requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation. Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.

PART 2 PRODUCTS

2.01 POWER SYSTEM ANALYSIS SOFTWARE

- A Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. SKM Systems Analysis, Inc.
- B Comply with IEEE 242 and IEEE 399.
- C Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.
- E Computer program must be designed to perform coordination studies or have function, component, or add-on module designed to perform coordination studies.
- F Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.02 COORDINATION 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 kVA and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
 - 6. Revisions to electrical equipment required by study.

7. Study Input Data: As described in "Power System Data" Article.
 - a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- D Protective Device Coordination Study:
 1. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.
 - a. 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.
 - b. Fuses: Show current rating, voltage, and class.
- E 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 switching schemes and for emergency periods where power source is local generation. Show the following information:
 1. Device tag and title, one-line diagram with legend identifying portion of system covered.
 2. Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
 3. Identify 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. Largest feeder circuit breaker in each motor-control center and panelboard.
 5. Maintain selectivity for tripping currents caused by overloads.
 6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
 7. Provide adequate time margins between device characteristics such that selective operation is achieved.
 8. Comments and recommendations for system improvements.

PART 3 EXECUTION

3.01 EXAMINATION

- A Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.02 POWER SYSTEM DATA

- A Obtain data necessary for conduct of overcurrent protective device study.
 - 1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.
 - 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
 - 3. For equipment that 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 must be in accordance with NFPA 70E.
- B Gather and tabulate required input data to support coordination study. List below is guide. Comply with recommendations in IEEE 551 for amount of detail required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:
 - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Electrical power utility impedance at 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 loads.
 - 6. Voltage level at each bus.
 - 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - 8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 - 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 - 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 - 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 - 12. Maximum demands from service meters.
 - 13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
 - 14. Motor horsepower and NEMA MG 1 code letter designation.

15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
17. 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 condition where available fault current is greater than 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.

3.03 COORDINATION STUDY

- A Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B Comply with IEEE 399 for general study procedures.
- C Base study on device characteristics supplied by device manufacturer.
- D Extent of electrical power system to be studied is indicated on Drawings.
- E Begin analysis at service, extending down to system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 5 kA or less.
 2. Exclude equipment supplied by single transformer smaller than 75 kVA.
- F Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G Transformer Primary Overcurrent Protective Devices:
 1. Device must not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings must protect transformers according to IEEE C57.12.00, for fault currents.

- H Motor Protection:
 - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 - 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I 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 maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- J Generator Protection: Select protection according to manufacturer's instructions and to IEEE 242.
- K Include 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 fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.
- L Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.
 - 1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.
- M Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
 - 3. Application of series-rated devices must be recertified, complying with requirements in NFPA 70.
 - 4. Include in report identification of protective device applied outside its capacity.

END OF SECTION 26 05 73.16

SECTION 26 05 73.19

ARC-FLASH HAZARD ANALYSIS

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Computer-based, arc-flash study to determine arc-flash hazard distance and incident energy to which personnel could be exposed during work on or near electrical equipment.
- B Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
 - 3. Section 260573.13 "Short-Circuit Studies" for fault-current studies.
 - 4. Section 260573.16 "Coordination Studies" for overcurrent protective device coordination studies.

1.02 DEFINITIONS

- A Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D p.u.: Per unit. The reference unit, established as a calculating convenience, for expressing all power system electrical parameters on a common reference base.
- E SCCR: Short-circuit current rating.
- F Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- G Single-Line Diagram: See "One-Line Diagram."

1.03 ACTION SUBMITTALS

- A Product Data:
 - 1. For power system analysis software to be used for studies.
- B Study Submittals:
 - 1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form:
 - a. Arc-flash study input data, including completed computer program input data sheets.
 - b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
 - c. Revised one-line diagram, reflecting field investigation results and results of arc-flash study.

1.04 INFORMATIONAL SUBMITTALS

- A Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.05 QUALITY ASSURANCE

- A Study must be performed using commercially developed and distributed software designed specifically for power system analysis.
- B Manual calculations are unacceptable.

1.06 REGULATORY AGENCY APPROVALS

- A Submittals for arc-flash hazard analysis requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation. Obtain approval by authorities having jurisdiction prior to submitting for action by Architect. Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.

PART 2 PRODUCTS

2.01 COMPUTER SOFTWARE

- A Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. SKM Systems Analysis, Inc.
- B Comply with IEEE 1584 and NFPA 70E.
- C Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D Computer program must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.
- E Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.02 ARC-FLASH STUDY REPORT CONTENT

- 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, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kVA and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D Study Input Data: As described in "Power System Data" Article.
- E Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- F Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- G Arc-Flash Study Output Reports:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in 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 symmetrical basis.

- g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.
- H 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.
- I Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

2.03 ARC-FLASH WARNING LABELS

- A Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce 3.5 by 5 inch self-adhesive equipment label for each work location included in analysis.
- B Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:
 - 1. Location designation.
 - 2. Nominal voltage.
 - 3. Protection boundaries.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. Limited approach boundary.
 - 4. Arc flash PPE category.
 - 5. Required minimum arc rating of PPE in Cal/cm squared.
 - 6. Available incident energy.
 - 7. Working distance.
 - 8. Engineering report number, revision number, and issue date.
- C Labels must be machine printed, with no field-applied markings.

PART 3 EXECUTION

3.01 EXAMINATION

- A Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.02 ARC-FLASH HAZARD ANALYSIS

- A Comply with NFPA 70E and its Annex D for hazard analysis study.
- B Preparatory Studies: Perform Short-Circuit and Protective Device Coordination studies prior to starting Arc-Flash Hazard Analysis.
 - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- C Calculate maximum and minimum contributions of fault-current size.
 1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.
 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.
 4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.
- D Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E Include medium- and low-voltage equipment locations, except equipment fed from transformers smaller than 75 kVA.
- F Calculate limited, restricted, and prohibited approach boundaries for each location.
- G Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must take into account changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:
 1. Fault contribution from induction motors must not be considered beyond three to five cycles.
 2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).
- H Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:
 1. When circuit breaker is in separate enclosure.
 2. When line terminals of circuit breaker are separate from work location.
- I Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.03 POWER SYSTEM DATA

- A Obtain data necessary for conduct of arc-flash hazard analysis.
 1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.
- B Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to amount of detail that is required to be acquired in field. Field data gathering must be under direct supervision and control of engineer in charge of performing

study, and must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at 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 loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.04 LABELING

- A Apply one arc-flash label on front cover of each section of equipment for each equipment included in study. Base arc-flash label data on highest values calculated at each location.
- B Each piece of equipment listed below must have arc-flash label applied to it:
1. Switchboards.
 2. Panelboards.
 3. Safety switches.
- C Note on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.
1. Indicate arc-flash energy.
 2. Indicate protection level required.

3.05 APPLICATION OF WARNING LABELS

- A Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

END OF SECTION 26 05 73.19

INTENTIONALLY LEFT BLANK

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SUMMARY

A Section Includes:

1. Indoor occupancy and vacancy sensors.

B Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.02 ACTION SUBMITTALS

A Product Data:

1. Indoor occupancy and vacancy sensors.

B Shop Drawings:

1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

1.04 WARRANTY

A Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.

1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices.
2. Extended Warranty Period: Three year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.01 INDOOR OCCUPANCY AND VACANCY SENSORS

A Manufacturers: Subject to compliance with requirements, provide products by the following :

1. Wattstopper .

B General Requirements for Sensors:

1. Wall Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Integrated Separate power pack.
4. Hardwired connection to switch .
5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A .
 8. Power: Line voltage .
 9. Power Pack: Dry contacts rated for 20 A LED load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
 10. Mounting:
 - a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
 - b. Relay: Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 12. Bypass Switch: Override the "on" function in case of sensor failure.
 13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C Dual-Technology Type: Wall Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch, and detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of when mounted 48 inch above finished floor.

PART 3 EXECUTION

3.01 EXAMINATION

- A Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF SENSORS

- A Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.03 INSTALLATION OF CONTACTORS

- A Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.04 INSTALLATION OF WIRING

- A Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- B Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.05 IDENTIFICATION

- A Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B Label time switches and contactors with a unique designation.

3.06 ADJUSTING

- A Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

END OF SECTION 26 09 23

INTENTIONALLY LEFT BLANK

SECTION 26 24 13 SWITCHBOARDS

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Switchboards.
 - 2. Surge protection devices.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Instrumentation.
 - 5. Control power.
 - 6. Accessory components and features.
- B Related Requirements
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
 - 3. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.02 COORDINATION

- A Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B Coordinate sizes and locations of concrete bases with actual equipment provided.

1.03 ACTION SUBMITTALS

- A Product Data:
 - 1. Switchboards.
 - 2. Overcurrent protective devices.
 - 3. Surge protection devices.
 - 4. Ground-fault protection devices.
 - 5. Accessories.
 - 6. Other components.
 - 7. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than UL 50E, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include diagram and details of proposed mimic bus.
11. Include schematic and wiring diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

1.05 CLOSEOUT SUBMITTALS

1.06 DELIVERY, STORAGE, AND HANDLING

- A Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B Handle and prepare switchboards for installation in accordance with NEMA PB 2.1.

1.07 WARRANTY

- A Special Manufacturer Extended Warranty: Manufacturer warrants that switchboard performs in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.
 1. Extended-Warranty Period: 5 years from date of Substantial Completion; full prorated coverage for labor, materials, and equipment.
 2. Follow-On Extended-Warranty Period: Five years from date of Substantial Completion; full coverage for materials that failed because of transient voltage surges only, free on board origin , freight prepaid.

PART 2 PRODUCTS

2.01 SWITCHBOARDS

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Siemens Industry, Inc., Energy Management Division.
 2. Square D; Schneider Electric USA.
- B Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- E Comply with NEMA PB 2.
- F Comply with NFPA 70.
- G Comply with UL 891.
- H Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
 2. Branch Devices: Panel mounted.
 3. Sections front and rear aligned.
- I Front- and Side-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted.
 2. Branch Devices: Panel mounted.
 3. Section Alignment: aligned.
- J Front- and Rear-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted.
 2. Branch Devices: Fixed, individually Fixed and individually compartmented Individually compartmented and drawout mounted.
 3. Sections front and rear aligned.
- K Indoor Enclosures: Steel, UL 50E, Type 1 .
- L Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over rust-inhibiting primer on treated metal surface.
- M Barriers: Between adjacent switchboard sections.
- N Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- O Service Entrance Rating: Switchboards intended for use as service entrance equipment may contain from one to six service disconnecting means with overcurrent protection, neutral bus with disconnecting link, grounding electrode conductor terminal, and main bonding jumper.
- P Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- Q Customer Metering Compartment: Separate customer metering compartment and section with front hinged door, and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring must be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- R Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- S Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- T Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- U Pull Box on Top of Switchboard:
1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 2. Set back from front to clear circuit-breaker removal mechanism.
 3. Removable covers may form top, front, and sides. Top covers at rear must be easily removable for drilling and cutting.
 4. Bottom must be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 5. Cable supports must be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

- V Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.
 2. Phase- and Neutral-Bus Material:
 - a. Hard-drawn copper of 98 percent conductivity.
 3. Copper feeder circuit-breaker line connections.
 4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 5. Ground Bus: 1/4 by 2 inch hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors.
 6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 7. Disconnect Links:
 - a. Isolate neutral bus from incoming neutral conductors.
 - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
 8. Neutral Buses: 100 percent of ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- W Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.02 SURGE PROTECTION DEVICES

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Siemens Industry, Inc., Energy Management Division.
 2. Square D; Schneider Electric USA.
- B SPDs: Listed and labeled in accordance with UL 1449, Type 1 .
- C Features and Accessories:
1. Integral disconnect switch.
 2. Internal thermal protection that disconnects SPD before damaging internal suppressor components.
 3. Indicator light display for protection status.
 4. Surge counter.
- D Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than 300 kA . Peak surge current rating must be arithmetic sum of ratings of individual MOVs in each mode.
- E SCCR: Equal or exceed 200 kA .
- F Nominal Rating: 20 kA.

2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
3. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
 - c. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.04 INSTRUMENTATION

- A Instrument Transformers: NEMA EI 21.1, and the following:
 1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, double secondary; disconnecting type with integral fuse mountings. Burden and accuracy must be consistent with connected metering and relay devices.
 2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; bar or window type; double secondary winding and secondary shorting device. Burden and accuracy must be consistent with connected metering and relay devices.
 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- C Voltmeters: Cover expanded-scale range of nominal voltage plus 10 percent.
- D Instrument Switches: Rotary type with off position.
 1. Voltmeter Switches: Permit reading of phase-to-phase voltages and, where neutral is indicated, phase-to-neutral voltages.
 2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in closed-circuit condition at all times.

- E Ammeters: 2-1/2 inch minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.
- F Watt-Hour Meters and Wattmeters:
 - 1. Comply with ANSI C12.1.
 - 2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
 - 3. Suitable for connection to three- and four-wire circuits.
 - 4. Potential indicating lamps.
 - 5. Adjustments for light and full load, phase balance, and power factor.
 - 6. Four-dial clock register.
 - 7. Integral demand indicator.
 - 8. Contact devices to operate remote impulse-totalizing demand meter.
 - 9. Ratchets to prevent reverse rotation.
 - 10. Removable meter with drawout test plug.
 - 11. Semiflush mounted case with matching cover.
 - 12. Appropriate multiplier tag.

2.05 CONTROL POWER

- A Control Circuits:
 - 1. 120 V(ac), supplied through secondary disconnecting devices from control-power transformer.
- B Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to primary side of each control-power transformer at line side of associated main circuit breaker. 120 V secondaries connected through automatic transfer relays to ensure fail-safe automatic transfer scheme.
- C Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- D Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.06 ACCESSORY COMPONENTS AND FEATURES

- A Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

PART 3 EXECUTION

3.01 EXAMINATION

- A Receive, inspect, handle, and store switchboards in accordance with NEMA PB 2.1.
 - 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
 - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
 - 3. Protect from moisture, dust, dirt, and debris during storage and installation.
 - 4. Install temporary heating during storage in accordance with manufacturer's published instructions.
- B Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

- C Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect performance of equipment.
- D Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

3.03 INSTALLATION

- A Comply with manufacturer's published instructions.
- B Reference Standards:
 - 1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 2.1.
 - 2. Consult Architect for resolution of conflicting requirements.
- C Special Techniques:
 - 1. Equipment Mounting: Install switchboards on concrete base, 4 inch nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."
 - a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch above concrete base after switchboard is anchored in place.
 - b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around full perimeter of concrete base.
 - c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
 - e. Install anchor bolts to elevations required for proper attachment to switchboards.
 - f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.
 - 2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
 - 3. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
 - 4. Install filler plates in unused spaces of panel-mounted sections.
 - 5. Install overcurrent protective devices, surge protection devices, and instrumentation.
 - a. Set field-adjustable switches and circuit-breaker trip ranges.
 - 6. Install spare-fuse cabinet.

3.04 CONNECTIONS

- A Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- B Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

- C Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.
- D Support and secure conductors within switchboard in accordance with NFPA 70.
- E Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.05 IDENTIFICATION

- A Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D Mimic Bus:
 - 1. Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.
 - 2. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce concise visual presentation of principal switchboard components and connections.
 - 3. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.
- E Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

3.06 FIELD QUALITY CONTROL

- A Field tests and inspections must be witnessed by authorities having jurisdiction .
- B Tests and Inspections:
 - 1. Acceptance Testing:
 - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
 - b. Test continuity of each circuit.
 - 2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 5. Perform the following infrared scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.

- c. Instruments and Equipment:
 - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C Nonconforming Work:
 - 1. Switchboard will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- E Manufacturer Services:
 - 1. Engage factory-authorized service representative to support field tests and inspections.

3.07 PROTECTION

- A Temporary Heating: Apply temporary heat, to maintain temperature in accordance with manufacturer's published instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION 26 24 13

INTENTIONALLY LEFT BLANK

SECTION 26 24 16 PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Power panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.
 - 4. Disconnecting and overcurrent protective devices.
- B Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.02 DEFINITIONS

- A GFEP: Ground-fault equipment protection.
- B MCCB: Molded-case circuit breaker.
- C VPR: Voltage protection rating.

1.03 ACTION SUBMITTALS

- A Product Data:
 - 1. Power panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.
 - 4. Disconnecting and overcurrent protective devices.
 - 5. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 6. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
 - 7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
 - 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

1.04 INFORMATIONAL SUBMITTALS

1.05 CLOSEOUT SUBMITTALS

1.06 DELIVERY, STORAGE, AND HANDLING

- A Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B Handle and prepare panelboards for installation in accordance with NECA 407.

PART 2 PRODUCTS

2.01 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction, and marked for intended location and application.
- C Comply with NEMA PB 1.
- D Comply with NFPA 70.
- E Enclosures: [**and**] Surface-mounted, dead-front cabinets.
 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: UL 50E, Type 1.
 - b. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E.
 2. Height: 7 ft maximum.
 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
 4. Finishes:
 - a. Panels and Trim: Steel , factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel Same finish as panels and trim.
- F Incoming Mains:
 1. Location: Top Convertible between top and bottom.
 2. Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.
- G Phase, Neutral, and Ground Buses:
 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating must run entire length of bus.
 - b. Bus must be fully rated for entire length.
 2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.

3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
 5. Do not mount neutral bus in gutter.
- H Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Tin-plated aluminum Hard-drawn copper, 98 percent conductivity.
 2. Terminations must 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: Compression type, with lug on neutral bar for each pole in panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Compression type, with lug on bar for each pole in panelboard.
 6. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 7. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 8. Gutter-Tap Lugs: Compression type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
- I Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- J Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 20 percent.
- K Panelboard Short-Circuit Current Rating:
1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.
 - a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
 - b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.
- L Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.02 POWER PANELBOARDS

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Siemens Industry, Inc., Energy Management Division.
 2. Square D; Schneider Electric USA.
- B Listing Criteria: NEMA PB 1, distribution type.
- C Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inch high, provide two latches, keyed alike.
- D Mains: Circuit breaker.
- E Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.
- G Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 1. External Control-Power Source: 24 V control circuit.

2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A Manufacturers: Subject to compliance with requirements, undefined:
 1. Siemens Industry, Inc., Energy Management Division.
 2. Square D; Schneider Electric USA.
- B Listing Criteria: NEMA PB 1, lighting and appliance branch-circuit type.
- C Mains: Circuit breaker.
- D Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 1. External Control-Power Source: 24 V control circuit.
- F Doors: Door-in-door construction with concealed hinges; secured with flush latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.

2.04 LOAD CENTERS

- A Manufacturers: Subject to compliance with requirements, undefined:
 1. Siemens Industry, Inc., Energy Management Division.
 2. Square D; Schneider Electric USA.
- B Listing Criteria: Comply with UL 67.
- C Mains: Circuit breaker or.
- D Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
- F Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A Manufacturers: Subject to compliance with requirements, undefined:
 1. Siemens Industry, Inc., Energy Management Division.
 2. Square D; Schneider Electric USA.
- B MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event must be recorded with type, phase, and magnitude of fault that caused trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long- and short-time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30 mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240 V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: style, suitable for number, size, trip ratings, and conductor materials.
 - e. Ground-Fault Protection: relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - f. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 A must have interchangeable rating plugs or electronic adjustable trip units.

PART 3 EXECUTION

3.01 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 in accordance with NEMA PB 1.1.
- C Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A Comply with manufacturer's published instructions.

B Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 1.1.
2. Consult Architect for resolution of conflicting requirements.

C Special Techniques:

1. Equipment Mounting:
 - a. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - b. Attach panelboard to vertical finished or structural surface behind panelboard.
 - c. Mount surface-mounted panelboards to steel slotted supports 1-1/4 inch in depth. Orient steel slotted supports vertically.
2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Mount top of trim 7.5 ft above finished floor unless otherwise indicated.
4. Mount panelboard cabinet plumb and rigid without distortion of box.
5. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
6. Install overcurrent protective devices and controllers not already factory installed.
 - a. Set field-adjustable, circuit-breaker trip ranges.
 - b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.
7. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
8. Install filler plates in unused spaces.
9. Stub four 1 inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four 1 inch empty conduits into raised floor space or below slab not on grade.
10. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
11. Mount spare fuse cabinet in accessible location.

D Interfaces with Other Work:

1. 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.

3.03 IDENTIFICATION

- A Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C Device Nameplates: Label each branch circuit device in power panelboards with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- D Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.
- E Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.
- F Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.
- G Circuit Directory:
 - 1. Provide directory card inside panelboard door, mounted in metal frame with transparent protective cover.
 - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
 - 2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
 - 3. Create directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.04 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 260573.16 "Coordination Studies."
- C Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
 - 1. Measure loads during period of normal facility operations.
 - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 - 4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

3.05 PROTECTION

- A Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 26 24 16

INTENTIONALLY LEFT BLANK

SECTION 26 27 13 ELECTRICITY METERING

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Electricity meters.
 - 2. Work to accommodate utility company revenue meters, and Owner's electricity meters used to manage electrical power system.
- B Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.02 DEFINITIONS

- A KY or KYZ Pulse: Term used by metering industry to describe method of measuring consumption of electricity (kWh) that is based on relay opening and closing in response to rotation of disk in meter. Electronic meters generate pulses electronically.

1.03 COORDINATION

- A Electrical Service Connections:
 - 1. Coordinate with utility companies and utility-furnished components.
 - a. Comply with requirements of utility providing electrical power services.
 - b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.04 ACTION SUBMITTALS

- A Product Data:
 - 1. For each type of meter.
 - 2. For metering infrastructure components.
 - 3. For metering software.
- B Shop Drawings: For electricity-metering equipment.
 - 1. Include elevation views of front panels of control and indicating devices and control stations.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
 - 4. Include series-combination rating data for modular meter centers with main disconnect device.
 - 5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.05 INFORMATIONAL SUBMITTALS

- A Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
 1. Installation of metering equipment.

1.06 CLOSEOUT SUBMITTALS

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- B Comply with UL 916.

2.02 UTILITY METERING INFRASTRUCTURE

- A Install metering accessories furnished by utility company, complying with its requirements.
- B Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by Utility.
 1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725. Comply with Section 260523 "Control-Voltage Electrical Power Cables."
- C Meter Sockets:
 1. Comply with requirements of electrical-power utility company.

PART 3 EXECUTION

3.01 INSTALLATION

- A Comply with manufacturer's published instructions.
- B Reference Standards:
 1. Install modular meter center according to switchboard installation requirements in NECA 400.
 2. Install arc-flash labels as required by NFPA 70.
- C Special Techniques:
 1. Install meters furnished by utility company. Install raceways and equipment according to utility company's published instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
 2. Wiring Methods:
 - a. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533.13 "Conduits for Electrical Systems."
 - b. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
 - c. Minimum conduit size is metric designator 16 (trade size 1/2).

3.02 IDENTIFICATION

- A Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.
 2. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide additional card holder suitable for printed, weather-resistant card with occupant's name.

3.03 PROTECTION

- A After installation, protect metering equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 27 13

INTENTIONALLY LEFT BLANK

SECTION 26 27 26 WIRING DEVICES

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 SUMMARY

- A Section Includes:
 1. Commercial-grade receptacles, 125 V, 20 A.
 2. GFCI receptacles, 125 V, 20 A.
 3. SPD receptacles, 125 V, 20 A.
 4. Toggle switches, 120/277 V, 20 A.
 5. Wall plates.

1.03 DEFINITIONS

- A AFCI: Arc-fault circuit interrupter.
- B BAS: Building automation system.
- C EMI: Electromagnetic interference.
- D GFCI: Ground-fault circuit interrupter.
- E Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F RFI: Radio-frequency interference.
- G SPD: Surge protective device.

1.04 ACTION SUBMITTALS

- A Product Data: For each type of product.
- B Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.05 CLOSEOUT SUBMITTALS

- A Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.06 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. SPD Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 PRODUCTS

2.01 GENERAL WIRING-DEVICE REQUIREMENTS

- A Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B Comply with NFPA 70.
- C RoHS compliant.
- D Comply with NEMA WD 1.
- E Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with requirements in this Section.

- F Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- G Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Gray unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. SPD Devices: Blue.
 - 3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.
- H Wall Plate Color: For plastic covers, match device color.
- I Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 COMERCIAL-GRADE RECEPTACLES, 125 V, 20 A

- A Duplex Receptacles, 125 V, 20 A:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Description: Two pole, three wire, and self-grounding.
 - 3. Configuration: NEMA WD 6, Configuration 5-20R.
 - 4. Standards: Comply with UL 498 and FS W-C-596.
- B Isolated-Ground Duplex Receptacles, 125 V, 20 A:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
 - 3. Configuration: NEMA WD 6, Configuration 5-20R.
 - 4. Standards: Comply with UL 498 and FS W-C-596.
- C Weather-Resistant Duplex Receptacle, 125 V, 20 A:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
 - 3. Configuration: NEMA WD 6, Configuration 5-20R.
 - 4. Standards: Comply with UL 498.
 - 5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.03 GFCI RECEPTACLES, 125 V, 20 A

- A Duplex GFCI Receptacles, 125 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
 3. Configuration: NEMA WD 6, Configuration 5-20R.
 4. Type: Non-feed through.
 5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
- B Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
 3. Configuration: NEMA WD 6, Configuration 5-15R.
 4. Type: Non-feed through.
 5. Standards: Comply with UL 498 and UL 943 Class A.
 6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.04 SPD RECEPTACLES, 125 V, 20 A

- A Duplex SPD Receptacles, 125 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 2. Description: Two pole, three wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
 3. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
 4. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
 5. Configuration: NEMA WD 6, Configuration 5-20R.
 6. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

- B Isolated-Ground Duplex SPD Receptacles, 125 V, 20 A:**
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 2. Description: Two pole, three wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
 3. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
 4. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
 5. Grounding: Equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
 6. Configuration: NEMA WD 6, Configuration 5-20R.
 7. Standards: Comply with UL 498, UL 1449, and FS W-C-596.

2.05 TOGGLE SWITCHES, 120/277 V, 20 A

- A Single-Pole Switches, 120/277 V, 20 A:**
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 2. Standards: Comply with UL 20 and FS W-S-896.
- B Three-Way Switches, 120/277 V, 20 A:**
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 2. Comply with UL 20 and FS W-S-896.
- C Four-Way Switches, 120/277 V, 20 A:**
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 2. Standards: Comply with UL 20 and FS W-S-896.

2.06 WALL PLATES

- A Single Source: Obtain wall plates from same manufacturer of wiring devices.
- B 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: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
 - 3. Material for Unfinished Spaces: 0.035 inch-thick, satin-finished, Type 302 stainless steel..
 - 4. Material for Damp Locations: 0.035 inch-thick, satin-finished, Type 302 stainless steel. with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- C Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.

PART 3 EXECUTION

3.01 INSTALLATION

- A Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
 2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
- F Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G Dimmers:
1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan-speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.
- H Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 GFCI RECEPTACLES

- A Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

- A Comply with Section 260553 "Identification for Electrical Systems."
- B Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black -filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- C Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.04 FIELD QUALITY CONTROL

- A Tests for Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- B Test straight-blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

- C Wiring device will be considered defective if it does not pass tests and inspections.
- D Prepare test and inspection reports.

END OF SECTION 26 27 26

INTENTIONALLY LEFT BLANK

SECTION 26 28 13 FUSES

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 SUMMARY

- A Section Includes:
 1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Enclosed switches.

1.03 ACTION SUBMITTALS

- A Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 3. Current-limitation curves for fuses with current-limiting characteristics.
 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
 5. Coordination charts and tables and related data.
 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.04 CLOSEOUT SUBMITTALS

1.05 FIELD CONDITIONS

- A Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Edison, Littlefuse, Mersen, USA.
- B Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.02 CARTRIDGE FUSES

- A Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.

4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, fast acting.
 5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
- B Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C Comply with NEMA FU 1 for cartridge fuses.
- D Comply with NFPA 70.
- E Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 EXECUTION

3.01 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.

3.02 FUSE APPLICATIONS

- A Cartridge Fuses:
1. Motor Branch Circuits: Class RK1, time delay.
 2. Large Motor Branch (601-4000 A): Class L, time delay.
 3. Provide open-fuse indicator fuses or fuses covers with open fuse indication.

3.03 INSTALLATION

- A Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.04 IDENTIFICATION

- A Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 50 00 LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A Section Includes:
 - 1. Luminaires.
 - 2. Luminaire fittings.
 - 3. Lamps.
- B Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Specifies wiring connections installed by this Section.
 - 3. Section 260529 "Hangers and Supports for Electrical Systems" specifies channel and angle supports installed by this Section.
 - 4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
 - 5. Section 260923 "Lighting Control Devices" specifies automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors installed by this Section.

1.02 DEFINITIONS

- A BUG Rating: Backlight, uplight, and glare rating for light pollution from exterior luminaires.
- B Correlated Color Temperature (CCT): The absolute temperature (in kelvins) of a blackbody whose chromaticity (color quality) most nearly resembles that of the light source.
- C Color Rendering Index (CRI): The measure of the degree of color shift objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference light source. The lower the CRI of a light source, the more difficult it is to identify colors and stripes on electronic components and wiring.
- D LED: Light emitting diode

1.03 ACTION SUBMITTALS

- A Product Data:
 - 1. For luminaires.
 - a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 - 1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
 - 2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
 - 3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.
 - b. Product Certificates: Include product certificates stating compliance with standards listed below, signed by manufacturer or fabricator.

- 1) Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with current accreditation under National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
- 2) Testing Agency Certified Data: For luminaires indicated on Lighting Fixture Schedule on Drawings, photometric data certified by qualified independent testing laboratory. Photometric data for remaining luminaires must be certified by manufacturer.
- c. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- d. Include operating characteristics, electrical characteristics, and furnished accessories.
- e. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on Drawings.
- f. Include battery and charger data for emergency lighting units.
- g. Include ballast factor.
- h. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
- i. Include photometric data and adjustment factors obtained from qualified laboratory tests.
- j. Include manufacturer's sample warranty language.
2. For luminaire fittings.
 - a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 - 1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
 - 2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
 - 3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.
 - b. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - c. Include operating characteristics, electrical characteristics, and furnished accessories.
 - d. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on Drawings.
 - e. Include manufacturer's sample warranty language.
3. For lamps.
 - a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 - 1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
 - 2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
 - 3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.
 - b. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- c. Include operating characteristics, electrical characteristics, and furnished accessories.
- d. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on Drawings.
- e. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
- f. Include manufacturer's sample warranty language.

1.04 INFORMATIONAL SUBMITTALS

1.05 CLOSEOUT SUBMITTALS

1.06 DELIVERY, STORAGE, AND HANDLING

- A Protect exposed surface finishes on lighting equipment by applying strippable, temporary protective covering before shipping.

PART 2 PRODUCTS

2.01 LUMINAIRES

- A Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - b. See individual product types below for listing criteria.
 - c. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.
 - B Surface-Mounted Luminaire:
 - 1. Product Description:
 - 2. Product Listing Criteria, LED: UL CCN IFAM; including UL 1598.
 - 3. Product Characteristics:
 - a. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from enclosure.
 - b. Nominal Operating Voltage: 120 V(ac).
 - c. Nominal Luminaire Operating Power Rating: 20 to 60 W.
 - d. CRI: 80+.
 - e. Ballast or Driver Location: Internal.
 - f. Materials:
 - 1) Enclosure: ASTM A568/A568M sheet steel housing and heat sink; free of sharp edges and burrs.
 - 2) Lenses, Diffusers, and Globes:
 - a) Fixed lens.
 - b) Wide light distribution.
 - c) Clear, heat- and UV-stabilized virgin acrylic plastic.
 - d) Lens Thickness: Not less than 0.125 inch unless otherwise indicated.
 - e) Distribution: Type III.
 - 3) Visible variations in metal finishes are unacceptable in adjoining components.
 - g. LED Luminaires (UL CCN IFAM):
 - 1) Output Intensity: Not less than 3000 lm.
 - 2) Efficacy: Not less than 80 lm/W.
 - 3) Rated Life: 50 000 hours to L70.
 - 4) CCT: 3500 K.

4. Required Product Options:
 - a. Mounting Hardware: Ceiling-mounted Pendant-mounted Wall-mounted Building-mounted; with integral mounting provisions.
 - b. Finishes:
 - 1) Enclosure: powder-coat finish.
 - 2) Reflector: Aluminum.
 - 3) Reflecting surfaces must have minimum reflectance as follows, unless otherwise indicated:
 - a) White Surfaces: 85 percent.
 - b) Specular Surfaces: 83 percent.
 - c) Diffusing Specular Surfaces: 75 percent.
 - c. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1) Finish designations prefixed by AA comply with system established by Aluminum Association for designating aluminum finishes.
 - 2) Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 - 3) Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin.
 - a) Chemical Finish: Etched, medium matte.
 - b) Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker), complying with AAMA 611.
 - 4) Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin.
 - a) Chemical Finish: Etched, medium matte.
 - b) Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
 - d. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1) Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 - 2) Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - e. Visible variations in metal finishes are unacceptable in adjoining components.
 - f. Dimmable from 100 percent to zero percent of maximum light output.
 - g. Stainless steel latches.
 - h. Integral pressure equalizer.
 - i. Photoelectric Switch: Factory-mounted integral to luminaire; listed and labeled in accordance with UL CCN WJFX, including UL 773, or in accordance with UL CCN WJCT, including UL 773A.
 - 1) Contact Relays: Factory mounted, single throw, designed to fail in on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15 s minimum time delay. Relay must have directional lens in front of photocell to prevent artificial light sources from causing false turn-off.

- a) Relay with locking-type receptacle must comply with NEMA C136.10.
- b) Adjustable window slide for adjusting on-off set points.
- j. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

2.02 LUMINAIRE FITTINGS

A Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- b. See individual product types below for listing criteria.

B Luminaire Support Accessories:

1. Product Characteristics:

- a. Sized and rated for luminaire weight.
- b. Capable of maintaining luminaire position after cleaning and relamping.
- c. Capable of supporting luminaire without causing deflection of ceiling or wall.
- d. Capable of supporting horizontal force equal to 100 percent of luminaire weight and vertical force equal to 400 percent of luminaire weight.

2. Required Product Options:

- a. Hook Hangers: Integrated assembly matched to luminaire, supply voltage, and equipment with threaded attachment, cord, and locking-type plug.
- b. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage wire supports 10 ft in length.
- c. Aircraft Cables: 5/32 inch diameter aircraft cable supports adjustable to 10 ft in length.
- d. Single-Stem Hangers: 1/2 inch nominal diameter steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- e. Rod Hangers: 3/16 inch nominal diameter, cadmium-plated, threaded steel rod.

2.03 LAMPS

A Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

PART 3 EXECUTION

3.01 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.

3.02 PREPARATION

A Shop Drawings: Prepare and submit the following:

1. Drawings, Diagrams, and Supporting Documents for Custom Luminaires:

- a. Include plans, elevations, sections, and mounting and attachment details.
- b. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- c. Include diagrams for power, signal, and control wiring.

- B Temporary Lighting: If approved by Architect, specified luminaires for Project may be installed for temporary lighting. Install and energize minimum quantity of luminaires necessary to meet needs of construction activities. When construction is sufficiently complete, remove, disassemble, clean, and relamp luminaires used for temporary lighting before reinstalling for Project delivery.

3.03 INSTALLATION OF LIGHTING

- A Comply with manufacturer's published instructions.
- B Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 1. Installation of Indoor Lighting Systems: NECA NEIS 500.
 2. Installation of Exterior Lighting Systems: NECA NEIS 501.
 3. Installation of Industrial Lighting Systems: NECA NEIS 502.
 4. Installation of Luminaires, Lampholders, and Lamps: Article 410 of NFPA 70.
 5. Installation of Lighting for Sensitive Electronic Equipment: Article 647 of NFPA 70.
 6. Installation of Emergency Lighting and Exit Signs: ICC IBC, NFPA 101, and Parts IV and V in Article 700 of NFPA 70.
 7. Consult Architect for resolution of conflicting requirements.
- C Systems Integration: Integrate lighting control devices and equipment with electrical power connections for operation of luminaires as specified.

3.04 PROTECTION

- A After installation, protect lighting equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 50 00

SECTION 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

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 SUMMARY

- A Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding labeling.

1.03 DEFINITIONS

- A BCT: Bonding conductor for telecommunications.
- B TGB: Telecommunications grounding busbar.
- C TMGB: Telecommunications main grounding busbar.
- D Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.04 ACTION SUBMITTALS

- A Product Data: For each type of product.
- B Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.05 INFORMATIONAL SUBMITTALS

- A As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. Ground rods.
 - 2. Ground and roof rings.
 - 3. BCT, TMGB, TGBs, and routing of their bonding conductors.
- B Qualification Data: For Installer, installation supervisor, and field inspector.
- C Qualification Data: For testing agency and testing agency's field supervisor.

1.06 CLOSEOUT SUBMITTALS

- A Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - a. Result of the ground-resistance test, measured at the point of BCT connection.
 - b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.07 QUALITY ASSURANCE

- A Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of ITS Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as a designer RCDD to perform the on-site inspection.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B Comply with UL 467 for grounding and bonding materials and equipment.
- C Comply with TIA-607-B.

2.02 CONDUCTORS

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panduit Corp.
 - 2. TE Connectivity Ltd.
- B Comply with UL 486A-486B.
- C Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 - 2. Cable Tray Equipment Grounding Wire: No. 6 AWG.
 - 3. Lead Content: Less than 300 parts per million.

2.03 CONNECTORS

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.
 - 2. Panduit Corp.
 - 3. TE Connectivity Ltd.
- B Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- C Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 - 1. Electroplated tinned copper, C and H shaped.

2.04 IDENTIFICATION

- A Comply with requirements for identification products in Section 27 05 53 "Identification for Communications Systems."

PART 3 EXECUTION

3.01 EXAMINATION

- A Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B Inspect the test results of the ac grounding system measured at the point of BCT connection.

- C Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B Comply with NECA 1.
- C Comply with TIA-607-B.

3.03 APPLICATION

- A Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.
- C Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
- D Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches.
- E Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch intervals.
 - 4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 05 28 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.04 GROUNDING ELECTRODE SYSTEM

- A The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.05 CONNECTIONS

- A Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B Stacking of conductors under a single bolt is not permitted when connecting to busbars.

- C Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pre-twist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- D Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- G Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
- H Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

3.06 IDENTIFICATION

- A Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
 - 2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
 - 3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

END OF SECTION 27 05 26

SECTION 27 05 28 PATHWAYS FOR COMMUNICATIONS SYSTEMS

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 SUMMARY

- A Section Includes:
 1. Metal conduits and fittings.
 2. Nonmetallic conduits and fittings.
 3. Optical-fiber-cable pathways and fittings.
 4. Hooks.
 5. Boxes, enclosures, and cabinets.
 6. Polymer-concrete handholes and boxes for exterior underground cabling.

1.03 DEFINITIONS

- A ARC: Aluminum rigid conduit.
- B GRC: Galvanized rigid conduit.
- C IMC: Intermediate metal conduit.
- D RTRC: Reinforced thermosetting resin conduit.

1.04 ACTION SUBMITTALS

- A Product data for the following:
 1. Surface pathways
 2. Wireways and fittings.
 3. Tele-power poles.
 4. Boxes, enclosures, and cabinets.
 5. Underground handholes and boxes.
- B Shop Drawings: For custom enclosures and cabinets and custom underground handholes and boxes. Include plans, elevations, sections, and attachment details.

PART 2 PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

- A Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Allied Tube & Conduit; a part of Atkore International.
 2. O-Z/Gedney; a brand of Emerson Industrial Automation.
 3. Wheatland Tube Company.
- C General Requirements for Metal Conduits and Fittings:
 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 2. Comply with TIA-569-D.
- D GRC: Comply with ANSI C80.1 and UL 6.
- E IMC: Comply with ANSI C80.6 and UL 1242.

- F EMT: Comply with ANSI C80.3 and UL 797.
- G Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- H Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS AND FITTINGS

- A Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- B Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Tube & Conduit; a part of Atkore International.
 - 2. CANTEX INC.
 - 3. Carlon; a brand of Thomas & Betts Corporation.
- C General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D RNC: Type EPC-40-PVC Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E Rigid HDPE: Comply with UL 651A.
- F Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.
- G Solvents and Adhesives: As recommended by conduit manufacturer.

2.03 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum installation unless otherwise indicated.
- B Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alpha Wire.
 - 2. Carlon; a brand of Thomas & Betts Corporation.
 - 3. IPEX USA LLC.
- C Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D Comply with TIA-569-D.

2.04 HOOKS

- A Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. MonoSystems, Inc.
 - 2. Panduit Corp.
 - 3. Wiremold / Legrand.

- C Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D Comply with TIA-569-D.
- E stainless steel.
- F U shape.

2.05 BOXES, ENCLOSURES, AND CABINETS

- A Description: Enclosures for communications.
- B Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 2. RACO; Hubbell.
 - 3. Thomas & Betts Corporation; A Member of the ABB Group.
- C General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 - 3. Gangable boxes are prohibited.
- D Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- E Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- F Metal Floor Boxes:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G Nonmetallic Floor Boxes: Nonadjustable, rectangular.
 - 1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

2.06 POLYMER-CONCRETE HANDHOLES

- A Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.
- B Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armorcast Products Company.
 - 2. Oldcastle Precast, Inc.
 - 3. Quazite: Hubbell Power Systems, Inc.
- C General Requirements for Polymer Concrete Handholes:
 - 1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 3. Comply with TIA-569-D and SCTE 77.
- D Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
- E Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 2. Cover Legend: Molded lettering, "COMMUNICATIONS".
- F Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- G Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-irons installed before concrete is poured.

PART 3 EXECUTION

3.01 PATHWAY APPLICATION

- A Outdoors: Apply pathway products as specified below unless otherwise indicated:
1. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
 2. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B Indoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 4. Damp or Wet Locations: GRC.
 5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
 6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
 7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.
- C Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.
- D Pathway Fittings: Compatible with pathways 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.
- E Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F Install surface pathways only where indicated on Drawings.
- G Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.02 INSTALLATION

- A Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.

6. NECA 105.
7. NECA 111.
- B Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D Comply with requirements in Section 27 05 29 "Hangers and Supports for Communications Systems" for hangers and supports.
- E Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G Complete pathway installation before starting conductor installation.
- H Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- J Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K Support conduit within 12 inches of enclosures to which attached.
- L Pathways Embedded in Slabs:
 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 3. Arrange pathways to keep a minimum of 1 inch of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 5. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.
- M Stub-ups to Above Recessed Ceilings:
 1. Use EMT, IMC, or RMC for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- P Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- Q Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- R Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

- S Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- T Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- U Surface Pathways:
 - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 - 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- V Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- W Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- X Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- Y Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- Z Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

BB Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

CC Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

DD Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

EE Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

FF Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG Set metal floor boxes level and flush with finished floor surface.

HH Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

A Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe of less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete around conduit for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 27 05 53 "Identification for Communications Systems."

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D Install handholes with bottom below frost line, 38" below grade.
- E Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.06 FIRESTOPPING

- A Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.07 PROTECTION

- A Protect coatings, finishes, and cabinets from damage or deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28

SECTION 27 05 29
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 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 SUMMARY

- A Section Includes:
1. Steel slotted support systems for communication raceways.
 2. Aluminum slotted support systems for communication raceways.
 3. Nonmetallic slotted support systems for communication raceways.
 4. Conduit and cable support devices.
 5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.

1.03 ACTION SUBMITTALS

- A Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 2. Include rated capacities and furnished specialties and accessories.
- B Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for communications hangers and support systems.
1. Trapeze hangers. Include product data for components.
 2. Steel slotted-channel systems.
 3. Aluminum slotted-channel systems.
 4. Nonmetallic slotted-channel systems.
 5. Equipment supports.
 6. 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.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design hanger and support system.
- B Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D635.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. Thomas & Betts Corporation; A Member of the ABB Group.
 - c. Unistrut; Part of Atkore International.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Material for Channel, Fittings, and Accessories: Stainless Steel, Type 304.
 - 4. Channel Width: Selected for applicable load criteria.
 - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 8. Channel Dimensions: Selected for applicable load criteria.
- B Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper Industries, Inc.
 - b. Thomas & Betts Corporation; A Member of the ABB Group.
 - c. Unistrut; Part of Atkore International.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Channel Material: 6063-T6 aluminum alloy.
 - 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 - 5. Channel Width: Selected for applicable load criteria.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 8. Channel Dimensions: Selected for applicable load criteria.
- C Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c., in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. G-Strut.
 - c. Haydon Corporation.
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Width: Selected for applicable load criteria.
 4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
 6. Rated Strength: Selected to suit applicable load criteria.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D Conduit and Cable Support Devices: Stainless-steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 2. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
 4. Toggle Bolts: Stainless-steel springhead type.
 5. Hanger Rods: Threaded steel.

2.03 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 Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 EXECUTION

3.01 APPLICATION

- A Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.

4. NECA 101.
- B Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C Comply with requirements for pathways specified in Section 27 05 28 "Pathways for Communications Systems."
- D Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

- A Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.
- B Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To New Concrete: Bolt to concrete inserts.
 2. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 3. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 4. To Light Steel: Sheet metal screws.
 5. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with strength and anchorage requirements.
- D Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A Comply with installation requirements in Section 05 50 00 "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 communications materials and equipment.
- C Field Welding: Comply with AWS D1.1/D1.1M.

3.04 PAINTING

- A Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

END OF SECTION 27 05 29

INTENTIONALLY LEFT BLANK

SECTION 27 05 53 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

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 SUMMARY

- B Section Includes:
 - 1. Color and legend requirements for labels and signs.
 - 2. Labels.
 - 3. Bands and tubes.
 - 4. Tapes.
 - 5. Signs.
 - 6. Cable ties.
 - 7. Fasteners for labels and signs.

1.03 ACTION SUBMITTALS

- C Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.
- D Identification Schedule:
 - 1. Outlets: Scaled drawings indicating location and proposed designation.
 - 2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
 - 3. Racks: Scaled drawings indicating location and proposed designation.
 - 4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A Comply with NFPA 70 and TIA 606-B.
- B Comply with ANSI Z535.4 for safety signs and labels.
- C Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS

- A Equipment Identification Labels:
 - 1. Black letters on a white field.

2.03 LABELS

- A Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. emedco.

- c. HellermannTyton.
 - d. Marking Services, Inc.
 - e. Panduit Corp.
 - f. Seton Identification Products; a Brady Corporation company.
- B Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. emedco.
 - c. HellermannTyton.
 - d. Ideal Industries, Inc.
 - e. Marking Services, Inc.
 - f. Panduit Corp.
 - g. Seton Identification Products; a Brady Corporation company.
 - 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.04 BANDS AND TUBES

- A Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. HellermannTyton.
 - c. Marking Services, Inc.
 - d. Panduit Corp.

2.05 UNDERGROUND-LINE WARNING TAPE

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Brady Corporation.
 - 2. Ideal Industries, Inc.
 - 3. Marking Services, Inc.
 - 4. Seton Identification Products; a Brady Corporation company.
- B Tape:
- 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- C Color and Printing:
- 1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.

2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL-FIBER CABLE".

2.06 SIGNS

A Laminated-Acrylic or Melamine-Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. emedco.
 - d. Marking Services, Inc.
2. Engraved legend.
3. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.07 CABLE TIES

A Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. HellermannTyton.
2. Ideal Industries, Inc.
3. Marking Services, Inc.
4. Panduit Corp.

B UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.08 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A Paint:** Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B Fasteners for Labels and Signs:** Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.01 PREPARATION

- A Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.02 INSTALLATION

- A Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B Install identifying devices before installing acoustical ceilings and similar concealment.
- C Verify identity of each item before installing identification products.
- D Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E Apply identification devices to surfaces that require finish after completing finish work.
- F Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- G Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- H Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 - 3. Provide label 6 inches from cable end.
- I Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- J Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- K Underground-Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
 - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.

3.03 IDENTIFICATION SCHEDULE

- A Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

- C Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
 - 1. Wiring closet designation.
 - 2. Colon.
 - 3. Faceplate number.
- D Equipment Room Labeling:
 - 1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
 - 2. Patch Panels: Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.
 - 3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
 - a. Room number being served.
 - b. Colon.
 - c. Faceplate number.
- E Backbone Cables: Label each cable with a vinyl-wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- F Horizontal Cables: Label each cable with a vinyl-wraparound label indicating the following, in the order listed:
 - 1. Room number.
 - 2. Colon.
 - 3. Faceplate number.
- G Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.
- H Instructional Signs: Self-adhesive labels.
- I Equipment Identification Labels:
 - 1. Indoor Equipment: Self-adhesive label Laminated-acrylic or melamine-plastic sign.
 - 2. Equipment to Be Labeled:
 - a. Communications cabinets.
 - b. Fire-alarm and suppression equipment.

END OF SECTION 27 05 53

INTENTIONALLY LEFT BLANK

SECTION 27 11 00 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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 SUMMARY

- A Section Includes:
 - 1. Backboards.
 - 2. Boxes, enclosures, and cabinets.
 - 3. Power strips.
- B Related Requirements:
 - 1. Section 27 13 23 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
 - 2. Section 27 15 13 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
 - 3. Section 27 15 23 "Communications Optical Fiber Horizontal Cabling" for coaxial data cabling associated with system panels and devices.

1.03 DEFINITIONS

- A Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B BICSI: Building Industry Consulting Service International.
- C RCDD: Registered communications distribution designer.
- D Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- E TGB: Telecommunications grounding bus bar.
- F TMGB: Telecommunications main grounding bus bar.

1.04 ACTION SUBMITTALS

- A Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.05 INFORMATIONAL SUBMITTALS

- A Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.06 QUALITY ASSURANCE

- A Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 PRODUCTS

2.01 BACKBOARDS

- A Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.
- B Backboard Paint: Pre-painted.

2.02 BOXES, ENCLOSURES, AND CABINETS

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. EGS/Appleton Electric.
 2. Hubbell Incorporated.
 3. MonoSystems, Inc.
 4. O-Z/Gedney; a brand of Emerson Industrial Automation.
 5. Thomas & Betts Corporation; A Member of the ABB Group.
 6. Wiremold / Legrand.
- B General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.
- C Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, ferrous alloy, with gasketed cover.
- E Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- G Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep.
- H Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Fiberglass.
 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- I Cabinets:
1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.03 POWER STRIPS

- A Power Strips: Comply with UL 1363.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Rack mounting, with detachable integral flanges.
 - 3. Height: 1 RU.
 - 4. Housing: Metal.
 - 5. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
 - 6. Rear-facing receptacles.
 - 7. LED indicator lights for power and protection status.
 - 8. LED indicator lights for reverse polarity and open outlet ground.
 - 9. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
 - 10. Cord connected with 15-foot line cord.
 - 11. Rocker-type on-off switch, illuminated when in on position.
 - 12. Surge Protection: UL 1449, Type 3.
 - a. Maximum Surge Current, Line to Neutral: 72 kA.
 - b. Protection modes shall be line to neutral, line to ground, and neutral to ground.
 - c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be 600 V and 500 V. for neutral to ground.

PART 3 EXECUTION

3.01 ENTRANCE FACILITIES

- A Comply with requirements in Section 27 05 28 "Pathways for Communications Systems" for materials and installation requirements for buried pathways.

3.02 INSTALLATION

- A Comply with NECA 1.
- B Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.
- C Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- D Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

- F Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- G Backboards:
 - 1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
 - 2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
 - 3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.03 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.04 FIRESTOPPING

- A Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- B Comply with TIA-569-D, Annex A, "Firestopping."
- C Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 27 11 00

SECTION 27 13 23

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

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 SUMMARY

- A Section Includes:
 - 1. 9/125 micrometer single-mode, inside plant optical fiber cable (OS2).

1.03 DEFINITIONS

- A BICSI: Building Industry Consulting Service International.
- B Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C RCDD: Registered Communications Distribution Designer.

1.04 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

- A Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.05 ACTION SUBMITTALS

- A Product Data: For each type of product.
- B Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 3. Cabling administration drawings and printouts.
 - 4. Wiring diagrams to show typical wiring schematics including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Cross-connects.
 - f. Patch panels.
 - g. Patch cords.
 - 5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

- C Optical fiber cable testing plan.

1.06 INFORMATIONAL SUBMITTALS

- A Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B Product Certificates: For each type of product.
- C Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Patch-Panel Units: One of each type.
 - 2. Plugs: Ten of each type.
 - 3. Jacks: Ten of each type.

1.09 QUALITY ASSURANCE

- A Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.10 DELIVERY, STORAGE, AND HANDLING

- A Test cables upon receipt at Project site.
 - 1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
 - 2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.11 PROJECT CONDITIONS

- A Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

- A Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- D Grounding: Comply with TIA-607-B.

2.02 9/125 MICROMETER SINGLE-MODE, INSIDE PLANT OPTICAL FIBER CABLE (OS2)

- A Description: Single mode, 9/125-micrometer, 24 fibers, stranded loose tube, optical fiber cable.
- B Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. CommScope, Inc.
 - 3. General Cable; General Cable Corporation.
 - 4. Hitachi Cable America Inc.
 - 5. SYSTIMAX Solutions; a CommScope Inc. brand.
- C Standards:
 - 1. Comply with TIA-492CAAB for detailed specifications.
 - 2. Comply with TIA-568-C.3 for performance specifications.
 - 3. Comply with ICEA S-83-596 for mechanical properties.
- D Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.
- E Jacket:
 - 1. Jacket Color: Yellow.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
- F Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP, or Type OFNR in metallic conduit.
 - 2. Riser Rated, Nonconductive: complying with UL 1666.

2.03 SOURCE QUALITY CONTROL

- A Testing Agency: Engage a qualified testing agency to evaluate cables.
- B Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.
- C Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.
- D Cable will be considered defective if it does not pass tests and inspections.
- E Prepare test and inspection reports.

PART 3 EXECUTION

3.01 ENTRANCE FACILITIES

- A Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.02 WIRING METHODS

- A Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- B Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.03 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A Comply with NECA 1, NECA 301, and NECA/BICSI 568.
- B General Requirements for Optical Fiber Cabling Installation:
 - 1. Comply with TIA-568-C.1 and TIA-568-C.3.
 - 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 9. In the communications equipment room, provide a 10-foot- long service loop on each end of cable.
 - 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 - 11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- C Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

- D Installation of Cable Routed Exposed under Raised Floors:
 - 1. Install plenum-rated cable only.
 - 2. Install cabling after the flooring system has been installed in raised floor areas.
 - 3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.
- E Group connecting hardware for cables into separate logical fields.

3.04 FIRESTOPPING

- A Comply with requirements in Section 078413 "Penetration Firestopping."
- B Comply with TIA-569-D, Annex A, "Firestopping."
- C Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.05 FIELD QUALITY CONTROL

- A Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B Tests and Inspections:
 - 1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
 - 2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.
- C Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- D Remove and replace cabling where test results indicate that it does not comply with specified requirements.
- E End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F Prepare test and inspection reports.

END OF SECTION 27 13 23

INTENTIONALLY LEFT BLANK

SECTION 27 15 13 COMMUNICATIONS COPPER HORIZONTAL CABLING

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 SUMMARY

- A Section Includes:
 1. Category 8A twisted pair cable.
 2. Cable management system.
 3. Source quality control requirements for twisted pair cable.

1.03 DEFINITIONS

- A Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B EMI: Electromagnetic interference.
- C FTP: Shielded twisted pair.
- D F/FTP: Overall foil screened cable with foil screened twisted pair.
- E F/UTP: Overall foil screened cable with unshielded twisted pair.
- F IDC: Insulation displacement connector.
- G LAN: Local area network.
- H Jack: Also commonly called an "outlet," it is the fixed, female connector.
- I Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J RCDD: Registered Communications Distribution Designer.
- K Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- M S/FTP: Overall braid screened cable with foil screened twisted pair.
- N S/UTP: Overall braid screened cable with unshielded twisted pairs.
- O UTP: Unshielded (unshielded) twisted pair.

1.04 SUBMITTALS

- A General: Submit the following in accordance with the Conditions of Contract.
- B Submittals shall be made as complete systems including all required accessories and special Installation tools.
- C Manufacturers' complete installation instructions including the following information:
 1. Minimum bend radius
 2. Maximum pulling tension.
 3. Recommended and required installation pulling points (e.g., every 270degrees of bend in the raceway, or every 150feet of raceway)
 4. Recommended and required pulling lubricants, taking care to confirm lubricant is appropriate for cable being Installed.
 5. Provide information regarding all termination and connectors that shall be required for a complete installation.

1.05 CLOSEOUT SUBMITTALS

- A Maintenance Data: For splices and connectors to include in maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Connecting Blocks: One of each type.
 2. Faceplates: One of each type.
 3. Jacks: Ten of each type.
 4. Multiuser Telecommunications Outlet Assemblies: One of each type.
 5. Patch-Panel Units: One of each type.
 6. Plugs: Ten of each type.

1.07 QUALITY ASSURANCE

- A Provide work complying with all applicable codes, standards, and manufacturers' requirements.
- B UL Compliance: Comply with applicable requirements of UL Standard 910 "Test Method for Fire and Smoke Characteristics of Cable Used in Air Plenum Spaces". Provide products that are UL-listed and labeled as such.
- C Comply with the following Telecommunications Industry Association (TIA) and Electronic Industries Association (EIA) Standards:
 1. EIA 568-B.1 568-B.2 & 568-B.3 "Commercial Building Telecommunications Cabling Standard"
 2. EIA 569-A "Commercial Building Standard for Telecommunications Pathways and Spaces."
 3. EIA 606 "The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings"

1.08 DELIVERY, STORAGE, AND HANDLING

- A Test cables upon receipt at Project site.
 1. Test each pair of twisted pair cable for open and short circuits.

1.09 PROJECT CONDITIONS

- A Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

- A Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 PRODUCTS

1.11 PRODUCT DATA.

- A Provide manufacturer's product data sheets for the following to Library IT project manager assigned to project for approval before ordering any part of the voice and data network.
- B Patch Panels (for fiber, UTP, and voice)
- C Data and Voice materials
 1. Faceplates Cable (fiber, UTP, voice.)
 2. Patch cords
 3. Racks
 4. Cable Management Devices
 5. 110ConnectorBlocks

- D Labeling materials
- E All other equipment identified or inferred. Submit complete list for approval.

1.12 PERFORMANCE REQUIREMENTS

- A General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C Grounding: Comply with TIA-607-B.

1.13 GENERAL CABLE CHARACTERISTICS

- A Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
- B Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
- C Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- D Communications, Non-plenum: Type CMR complying with UL 1666 and ICEA S-103-701.
- E Communications, Non-plenum: Type CMP or Type CMR in listed plenum or riser communications raceway.
- F Communications, Non-plenum: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- G UTP Cable-Plenum Rated: Cabling is distributed throughout the floors.
- H All data and voice cabling are Belden bonded pair Category6A-plenum cable.
- I Cables for data and VoIP station cabling shall be color blue.
- J Cables for analog voice station cabling shall be color gray.
- K Cables for wireless access point station cabling shall be color yellow.
- L All patch cords are the responsibility of the contractor.
- M Patch cords must be from the approved manufacturer and specification. Tested
- N Patch cords must be compatible with the low voltage warranty system(s) use for
- O the cabling to which they connect.
- P Category 8A blue patch cords to cross-connect from patch panel to data switch.
- Q Category 8A gray patch cords to cross-connect from patch panel to voice switch.
- R Wireless access points will be provided by owner, to be installed by contractor.
- S Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- T RoHS compliant.

1.14 MODULAR JACKPLATES

- A Shall accept modular 8 position/8 conductor information jacks.
 - 1. Category 8A jacks shall be compatible with IEEE 802. 3 applications. Fully supports 10 Mbps, 100 Mbps, Gigabit and 10 Gigabit Ethernet applications at 328 ft. (100 m) over UTP.
 - 2. Each jack shall be an individually constructed unit and shall snap mount in an industry standard keystone opening.

3. Jacks shall have a temperature rating of -10 °C (14°F) to 60°C (140 °F) and be in conformance with ANSI/IA/EIA-568-B.2
4. Provide blue jacks for data outlet locations, gray jacks for analog voice locations, black jacks for AV, and yellow jacks for wireless access point outlet locations. Pin/pair assignment shall be 568-B.
5. Jacks shall utilize a paired punch down sequence. Cable pairs shall be maintained up to the I DC, terminating all conductors adjacent to its pair mate to maintain pair characteristics designed by the cable manufacturer.
6. Jacks shall accept snap on icons for identification or designation of applications.
7. Jacks shall be terminated and marked as T568B wiring.
8. Jacks shall be supplied with installed dust covers to protect the jack opening and internal elements during installation until the jack is in use.
9. Jacks shall be UL VERIFIED for TIA/EIA 568-B.2 Category GA electrical performance. Jacks shall be UL LISTED 1863 and CSA certified. Jacks shall be made by an ISO 9002 Certified Manufacturer.
10. Belden REV Connect jacks will be used for all terminations.
11. Provide 20 additional jacks of each type used as maintenance spare.

1.15 CATEGORY 3 TWISTED PAIR CABLE

- A Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 3 cable at frequencies up to 16 MHz.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Belden Inc.
 - b. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 3 cables.
- B Conductors: 100-ohm, 24 AWG solid copper.
- C Shielding/Screening: Shielded twisted pairs FTP.
- D Cable Rating: Plenum.
- E CATEGORY 6A TWISTED PAIR CABLE
- F Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6A cable at frequencies up to 5000MHz.
- G Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6A cables.
- H Conductors: 100-ohm, 23 AWG solid copper.
- I Shielding/Screening: Shielded twisted pairs (FTP).
- J Cable Rating: Plenum.
- K SOURCE QUALITY CONTROL
- L Testing Agency: Engage a qualified testing agency to evaluate cables.
- M Factory test cables on reels according to TIA-568-C.1.
- N Factory test twisted pair cables according to TIA-568-C.2.
- O Cable will be considered defective if it does not pass tests and inspections.
- P Prepare test and inspection reports.

PART 3 EXECUTION

1.16 WIRING METHODS

- A Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
 1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Section 27 05 28 "Pathways for Communications Systems."
- B Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

1.17 INSTALLATION OF PATHWAYS

- A Comply with requirements for demarcation point, cabinets, and racks specified in Section 27 11 00 "Communications Equipment Room Fittings."
- B Comply with Section 27 05 28 "Pathways for Communications Systems."
- C Comply with Section 27 05 29 "Hangers and Supports for Communications Systems."
- D Comply with Section 27 05 36 "Cable Trays for Communications Systems."
- E Drawings indicate general arrangement of pathways and fittings.

1.18 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A Comply with NECA 1 and NECA/BICSI 568.
- B General Requirements for Cabling:
1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 3. Install 110-style IDC termination hardware unless otherwise indicated.
 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 6. MUTOA shall not be used as a cross-connect point.
 7. Consolidation points may be used only for making a direct connection to equipment outlets:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.
 8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
 12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 13. In the communications equipment room, install a 10-foot-long service loop on each end of cable.

14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- C Public/Shared Space Wireless Access Point UTP Cabling:
1. A quantity of two (2) yellow Category6A plenum cables runs, each with a 10ft. cable coil, must be installed to each identified Access Point (AP) location. See drawings for locations.
 2. . All telecommunications cable runs must comply with current electrical, telecommunications, and fire codes. Cable lengths must not exceed 328'(100m) per Category6A standards.
 3. From each AP, two Category6A cables (primary station cable) shall be terminated to the patch panel
 4. Category 8A modular jacks are required on patch panel for the AP wire termination.
 5. Yellow modular jacks are to be mounted in Dual Port Surface Housings located at each AP location. The station cables are to be terminated, tested, and labeled.
 6. All required wall, floor and ceiling penetrations must be in accordance with current electrical, telecommunications, and fire codes. Cable support hardware is required for horizontal and vertical cabling per infrastructure specifications.
 7. All cables and APs (Access Point) are to be identified per owners designated labeling scheme.
 8. Wireless access points will be provided by owner according to current specifications. The installation will be performed by contractors at specified locations using mounting brackets. Two (2) yellow Category8A patch cords from dual port surface housing jacks to AP will be installed for each AP. Patch cords installed so they are not visible from the hallway.
 9. Access Point antennas, if required, will be provided by owner. Installation will be performed by contractor and mounted to AP, wall, or acoustical ceiling per manufacturer's instructions.
 10. Access points will be tested by before installation, and access points not functioning after the installation will be replaced by the contractor at no expense.
- D In-room/private Wireless Access Point UTP Cabling:
1. A quantity of one(1) yellow Category8A plenum cable run, with a 10ft. cable coil, must be installed to each Identified Access Point (AP) location. See drawings for locations.
 2. All cables will be installed directly to AP locations. Cables will be installed horizontally through drop ceilings and hard wall ceilings, and vertically through existing riser shafts. All telecommunications cable runs must comply with current electrical, telecommunications, and fire codes. Cable lengths must not exceed 328' (100 m) per Category 8A standards.
 3. From each AP, one Category 8A cable (primary station cable) shall be terminated to the patch panel.
 4. Yellow Category 8A modular jacks are required on patch panel for the AP wire termination.
 5. Yellow modular jacks are to be mounted in the Surface Housings located at each AP location. The station cables are to be terminated, tested, and labeled; testing results are to be provided to owner.
 6. All required wall, floor and ceiling penetrations must be in accordance with current electrical, telecommunications, and fire codes. Cable support hardware is required for horizontal and vertical cabling.
 7. All cables and APs (Access Point) are to be identified per owners designated labeling scheme.

8. Wireless access points will be provided by owner to current specifications. The installation will be performed by contractors at specified locations using mounting brackets. One (1) yellow Category 6A patch cords from dual port surface housing jacks to AP will be installed for each AP.
 9. Access Point antennas, if required, will be provided by owner. Installation will be performed by contractor and mounted to AP, wall, or acoustical ceiling per manufacturer's instructions.
 10. Access points will be tested before installation, and access points not functioning after the installation will be replaced by the contractor at no expense to owner.
- E Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
 4. Maintain 12" separation between cabling and electrical cables and conduits.
- F Group connecting hardware for cables into separate logical fields.
- G Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

1.19 FIRESTOPPING

- A Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- B Comply with TIA-569-D, Annex A, "Firestopping."
- C Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

1.20 GROUNDING

- A Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B Comply with TIA-607-B and NECA/BICSI-607.
- C Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

1.21 IDENTIFICATION

- A Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."
 - 1. Administration Class: Class 2.
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration, including optional identification requirements of this standard.
- C Cable Schedule: Install in a 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, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- 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. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 5. 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.
- F Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

- G Provide labeling to correspond between workstation and respective patch panel port per owners direction in accordance with owners labeling scheme.
- H Provide labeling to the front of the faceplate, on both ends of each cable, to the front of the patch panel. All terminations shall be made in room number order.

1.22 FIELD QUALITY CONTROL

- A Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B Tests and Inspections:
 - 1. Notify owners project manager ten (10) business days prior to testing. Owner has the right to witness any and all testing. Test UTP cable in accordance with TIA/EIA 568-B2.1 and manufacturer's specifications. Any measurement reported by the field tester shall have a specified accuracy (level III). Record and submit to owners project manager an electronic copy of all test results in a format deemed acceptable to owners ITS. Any software required to read the test results to be provided to owner at no expense. Failure to notify owner of testing will result in the Contractor having to retest all cables prior to final acceptance.
 - a. All UTP testing done by Fluke DTX 1800 or Fluke DSX 1500 tester to level 111.
 - 2. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 4. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- C Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- D Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F Prepare test and inspection reports.

END OF SECTION 27 15 13

INTENTIONALLY LEFT BLANK

SECTION 28 46 21.11

ADDRESSABLE FIRE-ALARM SYSTEMS

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 SUMMARY

- A Section Includes:
 - 1. Addressable fire-alarm system.
 - 2. Fire-alarm control unit (FACU).
 - 3. Manual fire-alarm boxes.
 - 4. System smoke detectors.
 - 5. Duct smoke detectors.
 - 6. Heat detectors.
 - 7. Fire-alarm notification appliances.
 - 8. Firefighters' two-way telephone communication service.
 - 9. Fire-alarm graphic annunciators.
 - 10. Fire-alarm remote annunciators.
 - 11. Fire-alarm addressable interface devices.
- B Related Requirements:
 - 1. Section 087100 "Door Hardware" for magnetic door holders that release in response to fire-alarm outputs.
 - 2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" or Section 260523 "Control Voltage Electrical Power Cables" for cables and conductors for fire-alarm systems.

1.03 DEFINITIONS

- A DACT: Digital alarm communicator transmitter.
- B EMT: Electrical metallic tubing.
- C FACU: Fire-alarm control unit.
- D High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
- E Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).
- F NICET: National Institute for Certification in Engineering Technologies.
- G PC: Personal computer.
- H Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 - 1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.

2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.04 SEQUENCING AND SCHEDULING

- A Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. When new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from building.
- B Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.05 ACTION 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.
 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 2. Include rated capacities, operating characteristics, and electrical characteristics.
- C Shop Drawings: For fire-alarm system.
 1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 2. Include plans, elevations, sections, and details, including details of attachments to other Work.
 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 4. Annunciator panel details as required by authorities having jurisdiction.
 5. Detail assembly and support requirements.
 6. Include voltage drop calculations for notification-appliance circuits.
 7. Include battery-size calculations.
 8. Include input/output matrix.
 9. 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.
 10. Include performance parameters and installation details for each detector.
 11. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 12. Provide program report showing that air-sampling detector pipe layout balances pneumatically within airflow range of air-sampling detector.
 13. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring and equipment required for HVAC unit shutdown on alarm.
 - c. Locate detectors in accordance with manufacturer's written instructions.

14. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 15. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- D Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer 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.

1.06 INFORMATIONAL SUBMITTALS

- A Field quality-control reports.
- B Qualification Statements: For Installer.
- C Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

1.07 CLOSEOUT SUBMITTALS

- A Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
 - g. Record copy of site-specific software.
 - h. Provide "Inspection and Testing Form" in accordance with "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.
 - i. Manufacturer's required maintenance related to system warranty requirements.
 - j. Abbreviated operating instructions for mounting at FACU and each annunciator unit.

- B Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
 - 4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 - 5. Keys and Tools: One extra set for access to locked or tamperproofed components.
 - 6. Audible and Visual Notification Appliances: One of each type installed.
 - 7. Fuses: Two of each type installed in system. Provide in box or cabinet with compartments marked with fuse types and sizes.
 - 8. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 - 9. Air-Sampling Fan: Quantity equal to one for every five detectors, but no fewer than one unit of each type.

1.09 QUALITY ASSURANCE

- A Installer Qualifications:
 - 1. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
 - 2. Installation must be by personnel certified by NICET as fire-alarm Level II technician.
 - 3. Obtain certification by NRTL in accordance with NFPA 72.
 - 4. Licensed or certified by authorities having jurisdiction.

1.10 WARRANTY

- A Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 ADDRESSABLE FIRE-ALARM SYSTEM

- A Description:
 - 1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn-and-strobe notification for evacuation.
- B Performance Criteria:
 - 1. Regulatory Requirements:

- a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.
2. General Characteristics:
 - a. Automatic sensitivity control of certain smoke detectors.
 - b. Fire-alarm signal initiation must be by one or more of the following devices and systems:
 - 1) Manual stations.
 - 2) Heat detectors.
 - 3) Smoke detectors.
 - 4) Duct smoke detectors.
 - 5) Automatic sprinkler system water flow.
 - c. Fire-alarm signal must initiate the following actions:
 - 1) Continuously operate alarm notification appliances.
 - 2) Identify alarm and specific initiating device at FACU, connected network control panels, off-premises network control panels, and remote annunciators.
 - 3) Transmit alarm signal to 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) Activate voice/alarm communication system.
 - 7) Switch HVAC equipment controls to fire-alarm mode.
 - 8) Activate stairwell and elevator-shaft pressurization systems.
 - 9) Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 10) Recall elevators to primary or alternate recall floors.
 - 11) Activate elevator power shunt trip.
 - 12) Record events in system memory.
 - d. Supervisory signal initiation must be by one or more of the following devices and actions:
 - 1) Valve supervisory switch.
 - 2) Alert and Action signals of air duct air-sampling detector system.
 - 3) Elevator shunt-trip supervision.
 - 4) FACU has lost communication with network.
 - e. System trouble signal initiation must be by one or more of the following devices and actions:
 - 1) Open circuits, shorts, and grounds in designated circuits.
 - 2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3) Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 - 4) Loss of primary power at FACU.
 - 5) Ground or single break in internal circuits of FACU.
 - 6) Abnormal ac voltage at FACU.
 - 7) Break in standby battery circuitry.
 - 8) Failure of battery charging.
 - 9) Abnormal position of switch at FACU or annunciator.
 - 10) Voice signal amplifier failure.
 - f. System Supervisory Signal Actions:

- 1) Initiate notification appliances.
 - 2) Identify specific device initiating event at FACU, connected network control panels, off-premises network control panels, and remote annunciators.
 - 3) After time delay of 200 seconds, transmit trouble or supervisory signal to remote alarm receiving station.
 - 4) Transmit system status to building management system.
 - 5) Display system status on graphic annunciator.
- g. Network Communications:
- 1) Provide network communications for fire-alarm system in accordance with fire-alarm manufacturer's written instructions.
 - 2) Provide network communications pathway per manufacturer's written instructions and requirements in NFPA 72 and NFPA 70.
 - 3) Provide integration gateway using BACnet for connection to building automation system.
- h. Document Storage Box:
- 1) Description: Enclosure to accommodate standard 8-1/2-by-11 inch manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
 - 2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
 - 3) Color: Red powder-coat epoxy finish.
 - 4) Labeling: Permanently screened with 1 inch high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
 - 5) Security: Locked with 3/4 inch barrel lock. Provide solid 12 inch stainless steel piano hinge.

2.02 FIRE-ALARM CONTROL UNIT (FACU)

- A Manufacturers: Existing Siemens Panel to remain and be reused:
- B Description: The existing system shall meet or be modified to meet the following performance criteria.
- C Performance Criteria:
1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
 2. General Characteristics:
 - a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
 - b. Include real-time clock for time annotation of events on event recorder and printer.
 - c. Provide communication between FACU and remote circuit interface panels, annunciators, and displays.
 - d. FACU must be listed for connection to central-station signaling system service. FACU is to be connected to campus system using a serial dialer with a two phone line, Digital Alarm Communication Transmitter (DACT).
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACU must provide minimum 500-event history log.

- f. Addressable Initiation Device Circuits: FACU must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
 - 1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: FACU must be listed for releasing service.
- g. Alphanumeric Display and System Controls: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, device in alarm, device in alarm location, supervisory, and component status messages and programming and control menu.
 - 1) Annunciator and Display: LCD, three line(s) of 80 characters, minimum.
 - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into system for control of smoke-detector sensitivity and other parameters.
- h. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 - 1) Pathway Class Designations: NFPA 72, Class C.
 - 2) Pathway Survivability: Level 1.
 - 3) Install no more than 50 addressable devices on each signaling-line circuit.
 - 4) Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.
- i. Serial Interfaces:
 - 1) One dedicated RS 485 port for remote station operation using point ID DACT.
 - 2) One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - 3) One USB port for PC configuration.
 - 4) One RS 232 port for air-aspirating smoke detector connection.
 - 5) One RS 232 port for voice evacuation interface.
- j. Stairwell and Elevator Shaft Pressurization: Provide output signal using addressable relay to start stairwell and elevator shaft pressurization system. Signal must remain on until alarm conditions are cleared, and fire-alarm system is reset. Signal must not stop in response to alarm acknowledge or signal silence commands.
 - 1) Pressurization starts when alarm is received at FACU.
 - 2) Alarm signals from smoke detectors at pressurization air supplies have higher priority than other alarm signals that start system.
- k. Notification-Appliance Circuit:
 - 1) Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72.
 - 2) Where notification appliances provide signals to sleeping areas, alarm signal must be 520 Hz square wave with intensity 15 dB above average ambient sound level or 5 dB above maximum sound level, or at least 75 dB(A-weighted), whichever is greater, measured at pillow.
 - 3) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.
- l. Elevator Recall: Initiate by one of the following alarm-initiating devices:
 - 1) Elevator lobby detectors except lobby detector on designated floor.
 - 2) Smoke detectors in elevator machine room.

- 3) Smoke detectors in elevator hoistway.
 - m. Elevator controller must be programmed to move cars to alternate recall floor if lobby detectors located on designated recall floors are activated.
 - n. Water-flow alarm connected to sprinkler in elevator shaft and elevator machine room must shut down elevators associated with location without time delay.
 - 1) Water-flow switch associated with sprinkler in elevator pit may have delay to allow elevators to move to designated floor.
 - o. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls must be connected to fire-alarm system.
 - p. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.
 - q. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as special module that is part of FACU.
 - r. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of central-control microphone. Amplifiers must comply with UL 1711.
 - 1) Allow application of, and evacuation signal to, indicated number of zones and simultaneously allow voice paging to other zones selectively or in combination.
 - 2) Programmable tone and message sequence selection.
 - 3) Standard digitally recorded messages for "Evacuation" and "All Clear."
 - 4) Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of FACU.
 - s. Status Annunciator: Indicate status of various voice/alarm speaker zones and status of firefighters' two-way telephone communication zones.
 - t. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.
 - u. Primary Power: 24 V(dc) obtained from 120 V(ac) service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory and DACT must be powered by 24 V(dc) source.
 - v. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.
 - w. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.
 - x. Batteries: Sealed lead calcium.
- D Accessories:
- 1. Instructions: Computer printout or typewritten instruction card mounted behind plastic or glass cover in stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe functional operation of system under normal, alarm, and trouble conditions.

2.03 MANUAL FIRE-ALARM BOXES

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Siemens.

- B 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 alarm, breaking-glass or plastic-rod pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
 2. Station Reset: Key- or wrench-operated switch.
 3. Able to perform at up to 90 percent relative humidity at 90 deg F.

2.04 SYSTEM SMOKE DETECTORS

- A Photoelectric Smoke Detectors:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Siemens.
 3. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 268.
 - b. General Characteristics:
 - 1) Detectors must be two-wire type.
 - 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - 3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
 - 4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - 6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
 - 7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - a) Primary status.
 - b) Device type.
 - c) Present average value.
 - d) Present sensitivity selected.
 - e) Sensor range (normal, dirty, etc.).
 - 8) Detector must have functional humidity range within 10 to 90 percent relative humidity.
 - 9) Color: White.
 - 10) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 15 or 20 deg F per minute.

- 11) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 or 155 deg F.
- 12) Multiple levels of detection sensitivity for each sensor.
- 13) Sensitivity levels based on time of day.

2.05 DUCT SMOKE DETECTORS

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Siemens.
- B Description: Photoelectric-type, duct-mounted smoke detector.
- C Performance Criteria:
1. Regulatory Requirements:
 - a. NFPA 72.
 - b. UL 268A.
 2. General Characteristics:
 - a. Detectors must be two-wire type.
 - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - d. Integral Visual-Indicating Light: LED type, indicating detector has operated.
 - e. Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
 - f. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
 - g. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
 - h. Each sensor must have multiple levels of detection sensitivity.
 - i. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - j. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.06 HEAT DETECTORS

- A Fixed-Temperature-Type Heat Detectors:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Siemens.
 3. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.

- 2) UL 521.
- b. General Characteristics:
 - 1) Actuated by temperature that exceeds fixed temperature of 190 deg F.
 - 2) Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - 4) Detector must have functional humidity range of 10 to 90 percent.
 - 5) Color: White.

2.07 CONTINUOUS LINEAR HEAT-DETECTOR SYSTEM

- A Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Siemens.
- B Performance Criteria:
 1. Regulatory Requirements:
 - a. NFPA 72.
 2. General Characteristics:
 - a. Detector Cable: Rated detection temperature of 155 deg F. Listed for "regular" service and standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow cable twist pressure to short circuit wires at location of elevated temperature.
 - b. Signals to FACU: Local system trouble must be reported to FACU as composite "trouble" signal. Alarms on each detection zone must be individually reported to central FACU as separately identified zones.
 - c. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.

2.08 FIRE-ALARM NOTIFICATION APPLIANCES

- A Fire-Alarm Audible Notification Appliances:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Siemens.
 2. Description: Horns, bells, or other notification devices that cannot output voice messages.
 3. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - b. General Characteristics:
 - 1) Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 2) Chimes, Low-Level Output: Vibrating type, 75 dB(A-weighted) minimum rated output.
 - 3) Chimes, High-Level Output: Vibrating type, 81 dB(A-weighted) minimum rated output.
 - 4) Sounders, High Volume 24 V(dc): Less than 6 mA of alarm current.
 - 5) Sounders, Low Volume 24 V(dc): Less than 4 mA of alarm current.
 - 6) Audible notification appliances must have functional humidity range of 10 to 95 percent relative humidity.

- 7) ISO Temporal 3 Evacuation Tone: 90 plus or minus 4 dB(A-weighted) at 24 V or as per drawings.
- 8) ISO Temporal 3 Alert Tone: 95 plus or minus 5 dB(A-weighted) at 24 V or as per drawings.
- 9) AS2220 Evacuation Tone: 93 plus or minus 4 dB(A-weighted) at 24 or as per drawings.
- 10) AS2220 Alert Tone: 93 plus or minus 5 dB(A-weighted) at 24 V or as per drawings.
- 11) Horns: Electric-vibrating-polarized type, 24 V(dc); with provision for housing operating mechanism behind grille. Comply with UL 464. Horns must produce sound-pressure level of 90 dB(A-weighted), measured 10 ft. from horn, using coded signal prescribed in UL 464 test protocol.
- 12) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B Fire-Alarm Visible Notification Appliances:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Siemens.
2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 1971.
 - b. General Characteristics:
 - 1) Rated Light Output:
 - a) 15/30/75/110 cd, selectable in field.
 - 2) Clear or nominal white polycarbonate lens mounted on aluminum faceplate.
 - 3) Mounting: Wall mounted unless otherwise indicated.
 - 4) For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
 - 5) Flashing must be in temporal pattern, synchronized with other units.
 - 6) Strobe Leads: Factory connected to screw terminals.
 - 7) Mounting Faceplate: Factory finished, red.

2.09 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

A Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Siemens.

B Performance Criteria:

1. Regulatory Requirements:
 - a. NFPA 72.
2. General Characteristics:
 - a. Include address-setting means on module.
 - b. Store internal identifying code for control panel use to identify module type.
 - c. Listed for controlling HVAC fan motor controllers.
 - d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.

- e. Integral Relay: Capable of providing direct signal to circuit-breaker shunt trip for power shut-down.
 - 1) Allow control panel to switch relay contacts on command.
 - 2) Have minimum of two normally open and two normally closed contacts available for field wiring.
- f. Control Module:
 - 1) Operate notification devices.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTERS (DACTS)

A Performance Criteria:

- 1. Regulatory Requirements:
 - a. NFPA 72.
- 2. General Characteristics:
 - a. DACT must be acceptable to remote central station and must be listed for fire-alarm use.
 - b. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU and automatically capture two telephone line(s) and dial preset number for remote central station. When contact is made with central station(s), signals must be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter must initiate local trouble signal and transmit signal indicating loss of telephone line to remote alarm receiving station over remaining line. Transmitter must automatically report telephone service restoration to central station. If service is lost on both telephone lines, transmitter must initiate local trouble signal.
 - c. Local functions and display at DACT must include the following:
 - 1) Verification that both telephone lines are available.
 - 2) Programming device.
 - 3) LED display.
 - 4) Manual test report function and manual transmission clear indication.
 - 5) Communications failure with central station or FACU.
 - d. Digital data transmission must include the following:
 - 1) Address of alarm-initiating device.
 - 2) Address of supervisory signal.
 - 3) Address of trouble-initiating device.
 - 4) Loss of ac supply.
 - 5) Loss of power.
 - 6) Low battery.
 - 7) Abnormal test signal.
 - 8) Communication bus failure.
 - e. Secondary Power: Integral rechargeable battery and automatic charger.
 - f. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 EXECUTION

3.01 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.

3.02 PREPARATION

- A Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.
- B Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service in accordance with requirements indicated:
 1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
 2. Do not proceed with interruption of fire-alarm service without Architect's, Construction Manager's, and Owner's written permission.
- C Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.03 INSTALLATION OF EQUIPMENT

- A Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction 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 other trades have completed cleanup must be replaced.
 2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.
- B Install wall-mounted equipment, with tops of cabinets not more than 78 inch above finished floor.
- C Manual Fire-Alarm Boxes:
 1. Install manual fire-alarm box in normal path of egress within 60 inch of exit doorway.
 2. Mount manual fire-alarm box on background of contrasting color.
 3. Operable part of manual fire-alarm box must be between 42 and 48 inch above floor level. Devices must be mounted at same height unless otherwise indicated.
- D Smoke- and Heat-Detector Spacing:
 1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing must not exceed 30 ft.
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A in NFPA 72.
 5. HVAC: Locate detectors not closer than 36 inch from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inch from lighting fixture and not directly above pendant mounted or indirect lighting.

- E Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.
- F Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inch long must be supported at both ends.
 - 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- G Air-Sampling Smoke Detectors: If using multiple pipe runs, runs must be pneumatically balanced.
- H Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- I Single-Station Smoke Detectors: Where more than one smoke alarm is installed within dwelling or suite, they must be connected so that operation of smoke alarm causes alarm in smoke alarms to sound.
- J 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.
- K Audible Alarm-Indicating Devices: Install not less than 6 inch below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.
- L Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch below ceiling. Install devices at same height unless otherwise indicated.
- M Device Location-Indicating Lights: Locate in public space near device they monitor.

3.04 ELECTRICAL CONNECTIONS

- A Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.05 CONTROL CONNECTIONS

- A Install control and electrical power wiring to field-mounted control devices.
- B Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."
- C Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.06 PATHWAYS

- A Pathways above recessed ceilings and in inaccessible locations may be routed exposed.
 - 1. Exposed pathways located less than 96 inch above floor must be installed in EMT.
- B Pathways must be installed in EMT.
- C Exposed EMT must be painted red enamel.

3.07 CONNECTIONS

- A For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inch from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
 - 1. Smoke dampers in air ducts of designated HVAC duct systems.
 - 2. Magnetically held-open doors.
 - 3. Electronically locked doors and access gates.
 - 4. Alarm-initiating connection to elevator recall system and components.
 - 5. Supervisory connections at valve supervisory switches.
 - 6. Supervisory connections at elevator shunt-trip breaker.
 - 7. Data communication circuits for connection to building management system.

3.08 IDENTIFICATION

- A Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
- B Install framed instructions in location visible from FACU.

3.09 GROUNDING

- A Ground FACU and 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.

3.10 FIELD QUALITY CONTROL

- A Field tests must be witnessed by authorities having jurisdiction.
- B Administrant for Tests and Inspections:
 - 1. Administer and perform tests and inspections.
- C Tests and Inspections:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. 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.
 - b. 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.
 - 2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. 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.

4. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
 5. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
 6. 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.
- D Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.
- E Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F Prepare test and inspection reports.
- G Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- H Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.11 DEMONSTRATION

- A Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Provide video recording of training to Owner.

3.12 MAINTENANCE

- A Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.13 SOFTWARE SERVICE AGREEMENT

- A Comply with UL 864.
- B Technical Support: Beginning at Substantial Completion, service agreement must include software support for two years.
- C Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.
1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

END OF SECTION 28 46 21.11

INTENTIONALLY LEFT BLANK

**SECTION 31 00 10
GENERAL PROVISIONS FOR CIVIL WORK**

PART 1 – GENERAL

1.01 These Special Provisions for the Civil Engineering sections amend or supplement the standard specifications only as noted. All provisions which are not amended or supplemented shall remain in full force and effect.

A. Applicable Sections:

1. 321216 Asphalt Paving
2. 321600 Curbs Gutters Sidewalks Driveways
3. 321723 Pavement Markings
4. 321726 Detectable Warning Field
5. 330513 Manholes and Structures
6. 334000 Storm Water Utilities
7. 347113 Vehicle Barriers - Traffic Control
8. 324113 Site Demolition
9. 312300 Excavation and Embankments
10. 312500 Environmental and Sedimentation Controls
11. 313219 Geosynthetic Stabilization Separation and Drainage
12. 321116 Subbase Courses
13. 321123 Aggregate Base Courses

1.02 SUMMARY

- A. The project involves grading and sitework related to improvements to the Vaughn Library in Ashland WI. The exterior work includes removals of concrete sidewalk and some curb and gutter sections, excavation around north, east and south foundations of building, waterproofing of existing foundation (see architectural plans), temporary traffic control, backfilling excavation, placement of geotextile fabric type SAS, placement of granular subbase, installation of drain tile underdrain, placement of compacted base, replacement of concrete curb and gutter and sidewalk at modified grades, installation of detectable warning fields. The work will also include the salvaging, temporary storage, and re-installation of existing bike racks, benches, signs, or other exterior items during construction.

1.03 SPECIAL PROVISIONS:

1.04 PUBLIC ACCOMODATION

- A. Close the existing sidewalk at the western limits of the work on Main Street, and immediately north of the north crosswalk at the intersection of 3rd St W on the west side of Vaughn Ave. Place Barricades at the closure to prevent pedestrian traffic. At the intersection of 6th Ave. W place a "Sidewalk Closed Ahead" on the south Main Street Sidewalk. Also place a "Sidewalk Closed Ahead" on the east side of the intersection of Vaughn Ave and Main Street on the south sidewalk route.

1.05 TEMPORARY SHORING AND EXCAVATION

- A. The removal of the sidewalk and soil along the foundation may require temporary shoring to support the existing street. The method of support will be the contractors choice as long as the method is compliant with OSHA standards regarding safe trenches.
- B. Backfilling of the trench shall follow any waterproofing requirements in the architectural or structural plans. If no details for backfill exist, then back fill with native soil compacted to 95% Standard Proctor Test. Take precautions that compaction efforts do not damage existing foundation.
- C. Slope top surface of backfilled native soils away from building edges to the limits of the excavation. At the limits place a 4" perforated underdrain HDPE pipe with a filter fabric, and connect to existing inlet as shown on the plans.

1.06 ASPHALT PAVEMENT

- A. For the patched of Asphalt Pavement, place type 4 MT 58-28 S asphalt mix.

END OF SECTION 03 00 10

SECTION 31 23 00 EXCAVATIONS AND EMBANKMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Excavation and Embankment consists of the excavation and satisfactory disposal of all materials taken from within the right-of-way or project site for the construction of the project cuts and fills in reasonably close conformity with the line, grades, thicknesses, and typical cross-sections shown on the Plans or established by the Engineer, including any required borrow excavation and/or off-site waste. Work also includes the removal and satisfactory disposal of surface and base courses, embankment surcharge, masonry walls, foundations of buildings, or other structures that lie within the right-of-way or project grading limits, stone fences, stone piles and surplus and unsuitable materials; the replacement of unsuitable material with satisfactory material; the trimming and finishing of the cuts and fills; and maintaining such work in a finished condition until acceptance.

1.02 CLASSIFICATION

- A. General. Excavation items will be classified as Excavation Common or Borrow as hereinafter described.
- B. Excavation Common. Excavation Common consists of the excavation of all materials in cuts shown in the Plans or discussed in the Contract that are within the grading area, or are in close proximity to the grading area and within the right-of-way or project site and are designated in the Plans as a source of needed materials for embankment formation.
- C. Borrow. Borrow consist of furnishing, excavating, hauling and placing approved material, provided by the Contractor, required for completion of embankments and other portions of the work when sufficient quantities of satisfactory material for such purposes cannot be obtained from within the limits of grading areas and material sources shown on the Plans or discussed in the Contract.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials for embankment consist of approved materials and will not contain logs, stumps, brush or other perishable material. Humus-bearing soils, in excess of the quantity needed for salvaged topsoil requirements, and other soils not suitable for roadbed or foundation construction may be placed in the outside edges of the embankment, beyond the limits of pavements or structures.
- B. Materials to be incorporated in the top 2 inches of earth embankments will be free from large stone, rock and broken concrete or other materials which would significantly affect scarifying, compacting, and finishing the subgrade.
- C. Materials placed in those portions of embankments through which it is proposed to bore holes for piling or to drive piling will be free from gravel, stone or broken concrete, or other material which would significantly affect the boring of holes or driving of piling.
- D. Borrow Material. The material furnished under the item Borrow consists of satisfactory soil, or a mixture of satisfactory soil, stone, gravel or other acceptable materials, which is of a character and quality

satisfactory for the purpose intended. The material must be free from sod, stumps, logs and other perishable and deleterious matter.

- E. Borrow Source. Negotiate with property owners or others from whom the Contractor proposes to obtain borrow material.

PART 3 - EXECUTION

3.01 EXCAVATION

A. Preparing Grading Area Foundation

1. Cut and properly dispose vegetation of a height greater than one foot before ground is broken for excavation or before embankment is placed thereon. Remove heavy sod and other perishable material underlying proposed embankments within the limits of assumed one to one slopes extending outward from the outer limits of the finished shoulder line or structure foundation. Remove, disposed of, or otherwise treat muck, peat and other unstable material.
2. Strip and stockpiled or otherwise salvaged all suitable topsoil material from within the grading area limits to the extent that is available and required for the performance of topsoil placement work proposed under the Contract. Stockpile excess topsoil from grading limits that will not be used for project related restoration at a location directed by Engineer. If no location is available for a stockpile the second option is to place topsoil along fill slopes to flatten grades where possible.
3. After suitable topsoil and required sod and other perishable or unsuitable materials have been removed, compacted or otherwise prepare the ground underlying proposed embankments as required to provide a foundation which will properly support the proposed embankment and which will permit attaining the density specified for the embankment.
4. Cut or form in the slopes steps or benches having vertical and horizontal faces to properly support the proposed embankment where embankment is to be placed on existing side slopes 10 feet or more in height and steeper than one vertical to three horizontal. Such steps may be cut or formed during the time of placing the embankment.
5. Remove completely to a depth of not less than two feet below the proposed finished grade line all pavements, asphaltic surfaces or rigid base courses occurring within the area of embankment slopes and underlying proposed embankments, or to such other depth as shown on the Plans.

B. Drainage during Construction

1. Maintain the work site in a well-drained condition at all times during construction. Blading or leveling operations is required when placing embankments and during the process of excavation except when such excavation is in ledge rock or areas where leveling is not practical or necessary. Provide temporary drainage if it is necessary in the prosecution of the work to interrupt existing surface drainage, sewers, or under drainage, until permanent drainage work is completed. The construction of all temporary drainage installations is incidental to the construction of the work.
2. Stockpile topsoil to preclude interference with or obstruction of surface drainage, if stored on the right-of-way or project site during construction operations.

3. Preserve and protect all existing tile drains, sewers, and other subsurface drains, or parts thereof, which in the judgment of the Engineer may be continued in service without change. Repair at the Contractor's own expense damage to such facilities.

C. Excavation below Subgrade

1. Remove deposits of frost-heave material, unstable silty soils, wet and unstable soil, topsoil containing considerable amounts of humus or vegetable matter, or other undesirable foundation material from the area within the embankment slopes to such depths below the proposed finished earth grade as shown on the Plans or as directed by the Engineer. Wherever feasible, slope and drain the bottoms of such excavations so that water does not accumulate therein.
2. Use backfill made from selected materials from Excavation Common, Borrow or Granular Backfill, as called for on the Plan, in the special provisions or as directed by the Engineer.
3. Payment will be made at the contract unit price for items used in backfill and for pertinent excavation items involved in excavation below subgrade, if a unit price contract applies to the work.

D. Grading Embankments

1. Use all suitable material removed from excavation in the construction of the embankment, as far as practicable, and at such other places as shown on the Plans.
2. Undercut or underfill all excavated slopes or areas and all embankment slopes or areas, designated to be covered with topsoil or salvaged topsoil, to the necessary depth to provide for the specified amount of topsoil or salvaged topsoil to be placed and finished to the required grade lines and section.
3. Avoid removing or loosening any material outside the required slopes. Replace and thoroughly compact any such material which may be removed or loosened to the required cross-section.
4. Grade all intersecting roads, approaches, entrances and driveways as shown on the Plans or as laid out in the field by the Engineer.
5. Do not dispose waste or surplus excavation within three feet of the edge of ditches or channels. Spread waste or surplus material in thin uniform layers neatly leveled and shaped. Remove roots, stumps, logs and other objectionable material in the slopes and bottoms of ditches and channels and the holes backfilled with suitable material, or be cut to conform to the cross-section shown on the Plans. Provide sufficient openings in spoil banks to permit surface drainage of adjacent lands. Provide suitable outlets or flumes from intercepting ditches to roadway ditches where necessary in accordance with the details shown on the Plans.

E. Marsh Excavation and Disposal

1. Complete excavation of the marshes as soon as practicable in order to obtain maximum settlement prior to proposed base and surface construction.
2. Excavate wet marshes having relatively unstable side slopes beginning at one end and proceed in one direction to the full width across the entire marsh immediately ahead of backfilling. Use a method and sequence of excavating and backfilling to assure, to the extent practicable, the

complete removal or displacement of all peat or muck from within lateral limits called for on the Plans or as staked by the Engineer, and to the bottom of the marsh or to firm support. Excavate any displaced peat or muck accumulating ahead of the advancing embankment toe.

3. Excavate dry marshes having relatively stable side slopes and firm bottoms, to the extent practicable, to the width shown on the Plans or as staked by the Engineer and to the bottom of the marsh, and the construct backfill in layers.

F. Removing Embankment Surcharge

1. Remove and dispose excess fill placed above the elevation for earth grade over deposits of unstable material to secure displacement or settlement. Remove surcharge only after the fill has reached stability or the required settlement, as determined by the Engineer.

G. Removing Masonry Walls, Foundations of Buildings, or Other Structures

1. Removing masonry walls, foundations of buildings, or other structures consists of the removal of walls or foundations to a minimum of 2 feet below earth subgrade, or 2 feet below the slopes or natural ground elevation as may be necessary due to the location of the walls or foundation. Break holes in basement floors to permit drainage. Backfill those portions of all basements or other openings resulting from the removal of buildings or other structures, or openings resulting from the removal of walls or foundations of such buildings or structures, lying within the shoulder lines of the new embankment, to subgrade elevation with suitable material from excavation unless Granular Backfill is specified.

H. Disposing of Stones, Broken Rock and Boulders

1. Place, insofar as possible, all stones, broken rock and boulders not required for other construction included in the Contract, in embankments outside the limits of any proposed structure or structure foundations, and fill completely the voids between them with satisfactory soil. Dispose material that cannot be incorporated in the work either by burying in the ground within the right-of-way or project site in an approved manner or by placing off the right-of-way or project site. Comply with all regulations relating to disposal of solid wastes when material is placed outside the right-of-way or project site. Obtain written permits for disposal from the Owner of the property upon which the material is placed, unless the material is disposed of at a licensed waste disposal operation. Furnish permits, or copies of permits to Engineer prior to such disposal. Do not deposit waste in wetlands.

I. Disposal of Surplus or Unsuitable Material

1. Conserve material containing humus or of a nature suitable to support vegetation but unsatisfactory for constructing embankments, when required, and utilized in salvaged topsoil operations. Use all surplus humus-bearing soils, and other excavated materials not suitable for embankment construction but suitable to uniformly widen embankments, to flatten slopes and to fill low places in the right-of-way or on the project site, unless otherwise provided.
2. Dispose surplus excavation which is not or cannot be disposed of by flattening slopes or filling in low places on the right-of-way or project in places provided by the Contractor. Comply with all regulations relating to disposal of solid wastes. Dispose of in a manner that will present a neat and trim appearance, and in a manner to neither create a nuisance nor cause pollution nor

siltation of natural watercourses, streams, lakes, wetlands or reservoirs. Do not dispose waste in wetlands.

J. Finish Grading

1. Complete grading, trimming and finishing prior to construction of the subbase, base or surface courses.
2. Make adjustments in slopes to avoid injury to standing trees or to harmonize with existing landscape features, especially at the intersection of cuts and fills, and the gradual transition to such adjusted slopes.
3. Round crests of earth cut banks as indicated on the Plans or as directed by the Engineer. If the rounding is not defined in the plans, round locations where slopes meet a minimum of 10 feet to create a smooth transition for lawn care and to improve appearance.
4. During grading operations and prior to placement of subbase, base or surface course, or topsoil for restoration, provide continuous maintenance of the grading area and perform all blading and repair work necessary to keep the grade smooth and to the required grade and cross-section.
5. Erosion control plans may be included in the plans. These plan may only address the control of erosion that could potentially leave the project site. During construction and prior to full turf re-establishment, perform additional erosion protection measures to keep the site protected from on-site erosion damage. Repair at no additional cost to the Owner all on-site damage cause by erosion during the construction.

K. Preservation of Trees and Shrubs

1. Preserve and protect trees and shrubs from scarring or other injury during grading operations.
2. Do not disturb the original ground around the trees within a minimum distance of one foot or twice the diameter of the tree, whichever is the greater distance during excavation operations. Cut cleanly exposed roots resulting from excavation and covered with humus-bearing soil.
3. When required on the Plans, protect trees or shrubs around which excavation or embankment is made by the construction of tree wells, built in accordance with the Plan details and as laid out in the field by the Engineer.

L. Dust Abatement

1. Minimize the dispersion of dust from the subgrade during grading and maintenance operations, until acceptance of the work, by the application of water or other approved dust control materials. Work performed to control dust is incidental to Excavation and Embankment or Base Course items.

M. Overhaul

1. The various items of work under the general heading of Earthwork includes all hauling and no allowance will be made for overhaul.

3.02 BORROW

A. Construction Methods

1. Clear and grub the area from which material for Borrow is to be obtained. Remove all sod or other perishable or unsuitable material from the proposed pit area. Excavate borrow pits in a manner to permit accurate measurement of the material excavated and incorporated in the work.
2. Dispose all stone, broken rock, boulders and other materials, which are not satisfactory for use in the work.
3. Dispose all stumps, trees, logs, brush, tops and other debris resulting from clearing and grubbing work in borrow pit area.
4. Except in the case of commercial pits, strip off available topsoil or other soil of a nature conducive to plant growth, overlying such pit, and placed in stockpiles in sufficient quantities to cover all surfaces of excavated areas within such pit to a depth of 4 to 6 inches. When the depth of topsoil overlying such pit is less than 4 inches, replace topsoil to the original depth. After the pit has been trimmed and finished, spread salvaged material uniformly over all excavated areas of the borrow pit, except as otherwise authorized by the Engineer in writing.
5. After the excavated areas of the pit have been topsoiled, fertilize and seed the pit and adjacent disturbed areas and associated haul roads except when fertilizing and seeding is not desired by the landowner.

3.03 EMBANKMENT

- A. Clear and grub before placing embankment materials. Remove ice and snow from the surface of the ground prior to placing embankment on the ground.
- B. Unless otherwise provided in the Contract, discontinue the construction of embankments in the fall or early winter when weather conditions prevail which will cause substantial freezing of the materials as they are placed in the embankment, except when the materials used are from rock excavation or are of a granular nature and contain only minor quantities of silt, clay, loam or similar materials.
- C. Placing Layers
 1. Construct embankment in layers, except as hereinafter specified. Begin construction of an embankment at the lowest point of the fill below the grade at the bottom of ravines, and construct in layers by spreading and leveling the material during placement. Spread individual layers evenly to uniform thickness throughout and approximately parallel with the finished grade for the full width of the embankment, unless otherwise directed. Do not exceed 8 inches with an individual layer; provided that on side hills too steep to operate hauling equipment, over low, wet ground, in marshes or when filling in water a single layer may be constructed to a thickness not greater than necessary to support the hauling equipment while placing subsequent layers.
- D. Placing in Marsh
 1. Construct embankments in trenches excavated across wet marshes or swamps, generally, by end dumping the fill material. Begin fill placement at one end of the marsh and proceed across

sufficiently close to the excavating operation to permit the excavating equipment to remove any displaced peat or muck as it accumulates ahead of the advancing embankment toe. Place fill material as deposited in a manner and to the height necessary to effectively displace unstable material from within the area of the proposed embankment. Build temporary surcharges, if required, to the height and horizontal dimensions designated on the Plans and progressively move ahead as the embankment advances.

2. When marsh areas are excavated in a dry condition, place embankment constructed in the excavation in layers and compacted to the extent practicable.

E. Placing Rock

1. Where the material for embankment consists of rocks, broken stone or fragmented material of such size as to render placing in 8 inch layers impractical, place material in the embankment in layers not exceeding in thickness the approximate average size of the larger rocks, provided the individual pieces are so placed that there will be no nesting and all the voids are filled with smaller stones and satisfactory soil or rock fines.

3.04 COMPACTION

- A. Except as otherwise provided for backfilling of wet marshes and construction of rock fills, compact all embankments in accordance with the requirements for Standard Compaction unless Special Compaction is called for on the Plans or in the Contract.
- B. Do not compact embankment material when the moisture content will cause excessive rutting by the hauling equipment, or excessive displacement or distortion under the compacting equipment. Where such conditions exist, allow the materials to dry prior to compacting. When necessary, accelerate drying of such materials by aeration or manipulation by means of blade graders, harrows, discs or other appropriate equipment.
- C. When the embankment material does not contain sufficient moisture to compact properly, add water in quantities deemed necessary to aid, accelerate and secure effective compaction.
- D. Standard Compaction
 1. Deposit the material for the embankment, spread and leveled, as hereinbefore provided, in layers generally not exceeding 8 inches in thickness before compaction. Compact each layer of the embankment to the degree that no further appreciable consolidation is evidenced under the action of the compaction equipment. Attain the required compaction for each layer before any material for a succeeding layer is placed thereon.
 2. Perform compaction by specialized compaction equipment, supplemented by hauling and leveling equipment routed and distributed over each layer of the fill to make use of the compaction afforded thereby; unless the Engineer determines the compaction attained by the use of only the hauling and leveling equipment is satisfactory and sufficient. Should the Engineer determine such compaction is satisfactory and sufficient, specialized compaction equipment will not be required.
 3. Specialized compaction equipment includes tamping rollers, pneumatic-tired rollers, vibratory rollers or other types of equipment designed for compaction which will produce the required results in the materials encountered and be subject to the approval of the Engineer.

4. Tamping rollers, when used for compaction, will exert a pressure of not less than 150 pounds per square inch on the tamping surface of each tamping foot in a transverse row.
5. Pneumatic-tire rollers or other equipment, when used for compaction, will have a mass of not less than 150 pounds per linear inch of overall rolling width.

E. Special Compaction

1. Deposit the material for the embankment upon the properly prepared ground surface, spread and leveled in layers generally not exceeding 8 inches in thickness before compaction. When the material being compacted is of a granular nature and the compacting equipment is adaptable for the purpose, the thickness of the layer may be increased to a maximum of 12 inches provided the required density is obtained. Compact each layer of the spread and leveled material, by means of suitable compaction equipment, to not less than the specified density before the succeeding layer is placed.
2. Compact all embankment material placed within the limits of assumed one to one slopes extending outward and downward from the outer limits of pavements or the foundations of structures to not less than the density specified for the embankment, and the embankment material placed outside such assumed slopes to be compacted in accordance with Standard Compaction.
3. Compact embankments of 6 feet or less in height to at least 95 percent of maximum density for their full depth. Compact the top 6 feet of embankments over 6 feet in height to at least 95 percent of maximum density. Compact those portions more than 6 feet below the finished subgrade to at least 90 percent of maximum density, except compact that embankment occurring within 200 feet of a bridge abutment to at least 95 percent of maximum density.
4. Determine maximum density in accordance with the Standard Proctor Test, AASHTO T 99, Method C, with replacement of the fraction of material retained on the $\frac{3}{4}$ -inch sieve with No. 4 sieve to $\frac{3}{4}$ -inch material. Determine density of compacted embankment material in accordance with AASHTO T 191 or by other approved methods.
5. If the material in the density sample differs in percentage of aggregate retained on a No. 4 sieve from that in the sample upon which maximum density was determined, adjust the maximum density in accordance with the approved Wisconsin Department of Transportation procedure.
6. The foregoing density requirements will not apply to portions of embankments constructed of materials which, because of numerous large stones or high percentages of material retained on the No. 4 sieve, cannot in the judgment of the Engineer be accurately tested in accordance with the above procedures for determining maximum or in-place dry density.

F. Subgrade Compaction in Cuts

1. Compact the finished earth subgrade in cut sections for a width equal to the width of the proposed pavement plus shoulders or structure foundation in accordance with Standard Compaction, unless Special Compaction is called for in the contract.

2. On grading projects where Special Compaction is required, compact the finished earth subgrade in cut sections to the width above described and to a depth of at least 6 inches to at least 95 percent of maximum density.

G. Shrinkage and Surcharge

1. When considered necessary by the Engineer, build embankments to such elevation above required grade to allow for settlement; or sufficient surcharge placed above the required elevation of earth grade over deposits of unstable material to secure displacement or settlement.

H. Slopes

1. Build embankment slopes to the lines and section shown on the Plans or as directed by the Engineer. Fill all voids the slopes of rock fill embankments with rock fines or soils and trim to a smooth uniform appearance.
2. Adjust construction of embankments, whose slopes are designated to receive topsoil or salvaged topsoil, whereby the placing of such topsoil will result in the finished embankment conforming to the required section.

I. Subgrade Intermediate Consolidation and Trimming

1. Maintain drainage during construction at the end of each work day. Consolidate and trim the subgrade to aid drainage and to protect against erosion. Consolidate and trim subgrade surface disturbed, operated over, or constructed during that work day sufficient to press all "float" material firmly against the subgrade and produce a tight, smooth, well-drained surface. Consolidate and trim surfaces when rain is imminent during the workday, sufficiently in advance of the rain to avoid ponding and erosion.
2. Rock, stone and boulders excavated by plowing and scarifying operations and required to be removed and disposed of will not be measured for payment.

J. Compensation

1. Embankment work prescribed in this section will not be measured or paid for directly is considered as included in the classes of Excavation Common, Borrow, Granular Backfill, and other items of work. Formation, compaction, shaping, sloping, trimming, finishing and maintaining of the embankments and all other incidental work is included in the work.

3.05 METHOD OF MEASUREMENT/BASIS OF PAYMENT

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.
- B. Excavation Common actually performed and accepted as herein provided and within the specified limits, will be measured in cubic yards in their original position, computed by the method of average end areas, with no correction for curvature, except where this method is not feasible and as hereinafter provided.

- C. Where the quantity of Excavation Common to be placed is such a minor amount that, in the judgment of the Engineer, the measurement of such minor quantity by the above method would be impractical, the measurement may be made by the cubic yard in the vehicle. Determine the capacity of each vehicle used for hauling the material to the nearest 0.1 cubic yard by the Engineer and adjust for material expansion in the vehicle (unless otherwise agreed to by the Engineer and Contractor, an expansion factor from original position to vehicle volume of 1.4 will be used).
- D. Boulders and surface stone of one cubic yard or more in volume will be measured individually and the volume computed from average dimensions taken in three directions.
- E. Excavation Common, measured as provided above, will be paid for at the contract unit price per cubic yard. That price is payment in full for all work specified, including all items of earth work designated on the Plan for which no separate unit prices are included in the Contract. The cost of removing walls, foundations, etc., the satisfactory disposal of material resulting therefrom, and the backfilling of basements or openings resulting from the removal of walls, foundations, etc., for which no separate unit prices are included in the Contract, will be considered included in the contract unit price for Excavation Common. Such payment includes full compensation for all equipment, tools, labor and incidentals necessary to complete the work. All hauling is included in the contract unit price per cubic yard.
- F. Borrow will be measured in cubic yards of volume in its original position, computed by the method of average end areas, with no correction for curvature or, if the Engineer elects, by the method of truncated prisms. Notify the Engineer sufficiently in advance of the time when excavation operations will be performed so as to permit accurate measurements of borrow pit. Sod or other unsuitable material removed, or material salvaged from borrow pits and used for covering surfaces of the excavated areas within such pits, as hereinbefore provided, will not be measured for payment. The Engineer may require the Contractor to remove topsoil or other unsuitable materials from the surface of the pit area prior to taking original cross-sections of the pit area and, upon completion of the excavation, to smooth or trim the pit, as required, to permit taking accurate final measurements of the area before the topsoil is replaced thereon. Any material excavated prior to the staking out and cross-sectioning of the borrow pit by the Engineer, and all excavated material in excess of that required for or not incorporated in the work, will not be included in the quantity measured for payment.
- G. Where the quantity of Borrow to be placed is of such a minor amount that in the judgment of the Engineer the measurement of such minor quantity by the above method would be impractical, the measurement may be made by the cubic yard in the vehicle. The capacity of each vehicle used for hauling the material will be determined by the Engineer to the nearest 0.1 cubic yard and adjusted for material expansion in the vehicle (unless otherwise agreed to by the Engineer and Contractor, an expansion factor from original position to vehicle volume of 1.4 will be used).
- H. The volume of borrow measured as provided above, will be paid for at the contract unit price per cubic yard for Borrow. That price is full compensation for furnishing all materials, unless otherwise provided; for all clearing, grubbing, excavating, sloping, shaping, trimming, loading, hauling, placing, watering and dust abatement unless otherwise provided, compacting; disposing of surplus and unsuitable material; for salvaging, stockpiling, rehandling and spreading salvaged material for covering surfaces of excavated areas within borrow pits; and for all labor, equipment, tools and incidentals necessary to complete the work.

END OF SECTION 31 23 00

**SECTION 31 25 00
ENVIRONMENTAL AND SEDIMENTATION CONTROLS**

PART 1 - GENERAL

1.01 SUMMARY

- A. This work shall consist of providing and maintaining temporary and permanent environmental controls for the construction site in accordance with applicable local, state, and federal regulations and permits. Environmental controls include dust control, debris control, water control, erosion and sediment control, and pollution control.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Silt Fence

1. Silt fence geotextile fabric shall consist of either woven or non-woven synthetic filter fabric. Non-woven fabric may be needle punched, heat bonded, resin bonded, or combinations thereof. All fabric shall meet the following requirements:

<u>Test</u>	<u>Method</u>	<u>Value*</u>
Minimum grab tensile strength in the machine direction	ASTM D 4632	120 lbs.
Minimum grab tensile strength in the cross machine direction	ASTM D 4632	100 lbs.
Maximum apparent opening size equivalent standard sieve	ASTM D 4751	No. 30
Minimum permittivity	ASTM D 4491	0.05 sec ⁻¹
Minimum ultraviolet stability percentage of strength retained after 500 hours of exposure	ASTM D 4355	70%

*All numerical values represent minimum/maximum average roll values. (For example, the average of minimum test results on any roll in a lot should meet or exceed the minimum specified values.)

2. Provide silt fence support posts as indicated on the Plans. Wooden lath are not acceptable for silt fence support posts. When heavy-duty silt fence is required, provide wire support fence with a minimum 14 gauge with a maximum six-inch mesh. Provide heavy-duty silt fence in sensitive areas, such as disturbed slopes adjacent to surface waters, as indicated in the Plans.

B. Erosion Mat

1. Erosion mats shall conform to the current edition of the Erosion Control Product Acceptability List (WisDOT PAL) published by the Wisconsin Department of Transportation (WISDOT). In general, Class I mats are short term duration/light duty; Class II mats are long term duration/medium duty; and Class III mats are permanent (100 percent synthetic) turf reinforcement mats (TRMs). Classes are further subdivided into types for specific installations and minimum product permissible shear stresses as follows:

Class	Type	Slope Shear Stress	Maximum Slope	Channel Shear Stress	Notes
I	A	1.0 lb/sf	2.5:1	NP ⁽¹⁾	Only suitable for slopes
I	B	1.5 lb/sf	2:1	1.5 lb/sf	Double netted
I	Urban A ⁽²⁾	1.0 lb/sf ⁽³⁾	4:1	NP	Only suitable for slopes
I	Urban B ⁽²⁾	1.0 lb/sf	2.5:1	NP	Only suitable for slopes
II	A	(Jute Fiber only, intended for sod reinforcement)			No minimum product permissible shear stress
II	B	2.0 lb/sf	2:1	2.0 lb/sf	Non-organic
II	C ⁽⁴⁾	2.0 lb/sf	2:1	2.0 lb/sf	Only 100% organic
III	A	2.0 lb/sf	2:1	2.0 lb/sf	Non-soil filled
III	B ⁽⁵⁾	2.0 lb/sf	2:1	2.0 lb/sf	Soil filled
III	C ⁽⁵⁾	3.5 lb/sf	2:1	3.5 lb/sf	Soil filled
III	D ⁽⁵⁾	5.0 lb/sf	1:1	5.0 lb/sf	Soil filled

Notes:

⁽¹⁾ NP – Not Permitted

⁽²⁾ Urban mats are 100 percent organic biodegradable intended for use in urban areas where mowing may be accomplished in 2 weeks, or in environmentally sensitive areas that have a high probability of entrapping animals in plastic netting.

⁽³⁾ No minimum product shear stress for netted mats. 1.0 lb/sf applies to non-netted mats.

⁽⁴⁾ For environmentally sensitive areas that have a high probability of entrapping animals in plastic netting.

⁽⁵⁾ Class III, types B, C, D (soil filled TRMs) must be covered with an approved mat for slope/channel application as applicable, which shall be considered incidental to the Class III mat.

The PAL lists all acceptable products and manufacturers for specific class and types of erosion mats.

C. Mulching Materials

1. Provide mulching material consisting of straw or hay in an air-dry condition, wood excelsior fiber, wood chips, or other suitable material of a similar nature, as approved by the Engineer, which is substantially free of noxious weed seeds and objectionable foreign matter. Marsh hay or reed canary hay is not acceptable. Straw and hay mulch that will be crimped shall have a minimum fiber length of 6 inches.
2. Mulching is neither necessary nor appropriate in ditches, critical areas, concentrated flow areas, adjacent to storm drain inlets where drainage areas exceed ½ acre, or slopes greater than 3:1. Do not use mulch adjacent to roadways with a posted speed limit greater than 35 miles per hour as traffic currents can cause it to erode. Install erosion mat (Class I) adjacent to storm drain inlets where mulch is desirable, unless otherwise directed by the Project Engineer.

D. Inlet Protection

1. Construct inlet protection devices with Type FF woven polypropylene geotextile fabric, as follows:

Test	Method	Value*
Grab Tensile Strength, lb.	ASTM D-4632	200 min.
Puncture Strength, lb.	ASTM D-4833	105 min.
Apparent Breaking Elongation, Machine Direction, %	ASTM D-4632	24 min.
Apparent Breaking Elongation, Cross Direction, %	ASTM D-4632	10 min.
Apparent Opening Size, μm	ASTM D-4751	600 max.
Permittivity, s^{-1}	ASTM D-4491	1.9 min.

*All numerical values represent minimum/maximum average roll values (i.e., the average of minimum test results on any roll in a lot should meet or exceed the minimum specified values).

2. Only Type FF Geotextile fabrics listed in the current edition of the WisDOT PAL list shall be accepted. Inlet protection fabric shall exceed inlet grate by 8 inches on all sides to allow removal, unless otherwise specified.
3. Inlet protection shall be constructed as Type A-D as indicated in the plans and details. Commercially manufactured inlet protection devices may be furnished only if listed in the current edition of the WisDOT PAL list.

E. Erosion Bales

1. Provide either straw or hay erosion bales installed in double rows as detailed on the Plans. They are intended to trap sediment and prevent channels from eroding by decreasing the velocity of low velocity and volume channel flows.

F. Alternate Ditch Checks

1. Alternate ditch checks listed on the PAL may be installed in lieu of erosion bale ditch checks and shall be paid for per lineal foot equivalent to erosion bale ditch checks as shown in the Plans. Temporary ditch checks may be reused if condition is acceptable to Engineer. Spacing of alternate ditch checks must be decreased from that specified for erosion bale ditch checks due to lessened barrier height to meet 2/3 height criteria. No additional payment will be made for additional alternate ditch check installations required, due to decreased spacing, compared to spacing of erosion bale ditch checks, unless alternate pay items exist.
2. Sediment logs shall consist of rolled wood excelsior fibers rolled in approximate diameters of 12 inches for medium duty and 20 inches for heavy duty applications. Sediment logs shall be trenched in 2 inches and be secured to the ground with 1-inch diameter wood stakes every two lineal feet across its length or as otherwise specified by manufacturer stakes shall be pounded in a minimum of 16 inches and no more than 6 inches of stake shall protrude above the height of the sediment long for maintenance crew safety or according to manufacturers recommendations. Sediment logs shall be installed for overtopping prior to flow around conditions, similar to erosion bale ditch checks. Accumulated silt or debris shall be removed by Contractor, and damaged logs shall be immediately repaired or replaced.

G. Sediment Tracking Pads

1. Provide sediment tracking pads at all construction site access points to prevent off site tracking of soil as indicated on the plans. Rock sediment tracking pads will be made of hard, durable, angular stone conforming to the follow table:

<u>Sieve Size</u>	<u>Percent by Weight Passing</u>
3"	100
2 1/2"	90-100
1 1/2"	25-60
3/4"	0-20
3/8"	0-5

2. Place filter fabric under stone.
3. Sediment tracking pads will be 18 inches thick, 50 feet long, and span across the full width of the entrance or a minimum of 12 feet wide with traffic restricted to passing over the 12 foot wide pad.
4. Proprietary reusable tracking pads are acceptable with prior approval by the engineer.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION

- A. Projects shall be staged to limit the amount of bare soil and allow for revegetation.
- B. Dust Control
 1. Minimize the dispersion of dust from the project area during construction. Maintain dust control until final acceptance of the work. Apply water or other approved dust control materials as directed by the Engineer. Comply with OSHA regulations regarding dust control efforts. Sweep streets where sediment has been tracked.
- C. Debris Control
 1. Initiate and maintain a program specifically to prevent the accumulation of debris at the construction site, storage, and parking areas, or along access roads and haul routes. Provide containers for disposal of debris. Prohibit overloading of trucks to prevent spillage on access and haul routes. Schedule periodic collection and disposal of debris.
- D. Erosion and Sediment Control
 1. Erosion and sediment control work consists of incrementally phasing disturbance and restoration, furnishing and installing stone tracking pads, inlet protection, street sweeping, erosion mats, silt fences, ditch checks, runoff diversions, sediment basins, and other erosion and sediment control devices in accordance with the Plans and as determined necessary by the Engineer.
 2. Projects disturbing more than one acre are subject to the requirements of the Wisconsin Department of Natural Resources (WDNR) WPDES General Storm Water Permit for Construction

Sites. A Storm Water Management Plan and an Erosion and Sediment Control Plan (Report) are developed for projects with a WPDES permit. The Best Management Practices (BMPs) selected for this project, as identified in the Report, are incorporated into the final Plans and specifications.

3. For all projects, perform installation, necessary maintenance on erosion control practices, assist in weekly inspections of erosion control practices, establishing final stabilization of the site or until the Notice of Termination has been filed with the DNR in the case of projects more than one acre, and removal of temporary BMPs.
4. For all projects, furnish the Engineer a project specific Erosion Control Implementation Plan (ECIP) one week prior to the preconstruction meeting or one week prior to commencing construction if a preconstruction meeting is not held. The ECIP shall be in accordance with the plans, report, and specifications. An ECIP worksheet is included in this specification for contractors use in developing an ECIP for this project.
5. Place down gradient sediment control measures where shown on the Plans and/or as directed by the Engineer prior to any grading or disturbance of existing surface material.
6. Provide periodic inspection and maintenance of sediment control structures to ensure the intended purposed is accomplished. Maintain sediment control measures in working condition at the end of each working day. Weekly and after 0.5 inches rainfall, inspect and document the condition of all BMPs unless indicated otherwise in the Special Provisions. A copy of WDNR Form 3400-187 construction Site Inspection Report is included at the end of this section. Any damaged or failing structures shall be repaired or replaced within 24 hours of discovery or as otherwise directed by the Engineer. Under normal conditions, ditch checks and silt fence barriers require removal of trapped sediment. Remove sediment deposits within 5 days of when deposits reach half the height of the barrier. If maintenance is difficult due to location or presence of wet soils that prohibit prompt cleaning after runoff events, construct additional barriers and sediment shall be removed within 5 days upon achieving access.
7. Install erosion control and sediment control measures per manufacturers recommendations including, but not limited to, furnishing and installing specified anchoring devices (such as staples in the case of erosion mats and stakes of specified thickness and length for sediment logs and ditch checks) and installation recommendations shall govern unless otherwise specified. Excess erosion mat may not be left on site unrolled; cut excess mat from the roll and remove from the site.
8. Use erosion bales on or at the toe of slopes to control sheet flow or to control channel flow in un-stabilized minor swales, ditches, or diversions with relatively small contributing drainage areas. The spacing between erosion bale barriers is determined based on the difference in elevation of the barriers. The difference in elevation between barriers may not exceed $\frac{2}{3}$ the height (14" effective height) of the erosion bale. (For example, a standard bale installed on a 2% grade allows the rows to be placed approximately 40 feet apart). Install erosion bales shall be placed of a width, as measured perpendicular to flow, that exceeds the expected width of water flow by at least one bale on each side so that storm water will overtop the top of bales, not go around them. In absence of specified channel erosion mat, Class II, Type B erosion mat shall be installed with all erosion bale ditch checks as detailed. Erosion bales may not be used in intermittent and perennial stream channels. Payment for erosion bales shall be on a lineal foot basis for (double rows) each separate installation. Payment for ditch check erosion mat shall be paid for separately as indicated in the bid documents, or incidental to the payment for erosion bale ditch checks in absence of a separate pay item for erosion mat. Payment will not be made for bales not trenched in or otherwise improperly installed.

9. Construct tracking pads with 18 inches minimum thickness. Direct runoff from tracking pads to an approved erosion control treatment device. Prevent water from running through the tracking pad by grading or using a culvert capable of passing the 2-year, 24-hour rain event.
10. Sweep tracked soil or otherwise remove by mechanical means from paved roads located near the construction site daily or as otherwise approved by the Engineer. Washing sediment from roads is not allowed. Inspect tracking pads daily and remove and replace materials when no longer effective, as determined by the Engineer.
11. Provide inlet protection at all storm sewer structures collecting runoff from the site. Contractor may furnish and install commercially manufactured inlet protection devices only if listed in the WisDOT PAL list.
12. Deep till/chisel plowing practices are required for areas compacted by construction equipment to restore soil infiltration properties. This work shall be considered incidental to topsoiling operations. Restore areas compacted by hauling activities prior to placement of topsoil on subsequent restoration efforts.
13. If mulch is called for in the plans, place mulch same day seeding has been completed. Prepare all areas to be mulched to be reasonably free of rills and gullies. Do not place mulch during periods of excessively high wind, which would preclude the proper placing of the mulch.
14. The placed mulch shall be loose or open enough to allow air to slowly circulate, but thick enough to shade the ground, conserve soil moisture and prevent or reduce erosion. Place mulch to provide 100% coverage at the time of initial placement. Spread out thick clumps that do not allow air movement through the mulch mat to avoid mold growth from sealing the surface and restricting growth opportunity for new grass.
15. Maintain mulched areas and shall repair any areas damaged by wind, erosion, traffic, fire or other causes prior to final or partial acceptance of work under the contract.
16. The contractor may perform the work as specified in one of the following ways: Method A, Method B, or Method C, or a combination of the 3, unless a specific method is specified in the contract.

E. Method A, Netting

1. Uniformly spread the mulching material over the designated areas to a loose depth of 1/2 to 1 1/2 inches. Loosen or make fluffy the mulch material from compacted bales before spreading in place. Unless directed otherwise, begin mulching at the top of the slopes and proceed downward.
2. Securely anchor straw or hay mulch by using engineer-approved netting anchored to the ground with pegs or staples to prevent it from floating as the vegetation grows. Instead of this anchorage, the contractor may secure mulch by heavy biodegradable twine fastened by pegs or staples to form a grid with 6 to 10 feet spacing.
3. The contractor may use department-approved erosion control mats, listed in the WisDOT PAL, instead of separately applying mulch and netting.
- 4.

F. Method B, Tackifier

1. Treat straw or hay with a tackifier, blow from a machine, and uniformly deposit over designated areas in one operation. Place straw or hay uniformly over the area 1/2 to 1 inch deep, using 1/2 to 3 tons of mulch per acre. Mix and place tackifier according to the WisDOT PAL. Within the above limits, the engineer will review, on the job, the application rate of the mulch and the tackifier, and the engineer may request the contractor to vary the rates during mulching to produce the desired results. Use an engineer-approved machine to place the mulch that blows or ejects by constant air stream a controlled quantity of mulch and applies a spray of tackifier to partially coat the straw or hay, sufficient to hold together and keep in place the deposited straw or hay. The contractor may apply the tackifier as an overspray in a separate operation after placing the straw or hay.
2. Apply wood fiber, wood chips, or similar material with engineer-approved blowing machines, or other engineer-approved methods, that place a controlled quantity of mulch uniformly over the area 1/2 to 1 1/2 inches deep. Treat areas receiving wood chip mulch, with one pound of available nitrogen per 1000 square feet before or after applying the chips.
3. Throughout the process, feed the mulch material into the blowing machine to produce a constant and uniform ejection from the discharge spout, and operate in a position to produce mulch of uniform depth and coverage.

G. Method C, Crimping

1. Spread the straw or hay mulch uniformly over the designated areas to a loose depth of 1/2 to 1 1/2 inches, using 1/2 to 3 tons of mulch per acre, by blowing from a machine, as specified in Method B, or by other engineer-approved methods.
2. Immediately after spreading, anchor the mulch in the soil by using a mulch crimper consisting of a series of dull, flat discs with notched edges. Space the 20 inch diameter discs at about 8 inch centers. Equip the crimper with a ballast compartment to allow adjusting the weight for depth control.
3. Impress the mulch into the soil 1 1/2 to 2 1/2 inches deep in one pass of the crimper. The department will not allow mulch crimpers to operate on slopes so steep that damage to the mulch, seedbed, or soil occurs. Anchor the mulch on these areas by one of the following methods: Method A or Method B. Equip and operate tractors to minimize disturbing or displacing the soil. This process may require more than one pass of the crimper to ensure adequate anchoring of the mulch.
4. The contractor shall not use Method C if it cannot impress the mulch to a minimum of 1 1/2 inch.
5. Contractor may opt to integrate Seeding Method B with Method B, Tackifier. This mulching method is required for all urban (lawn-type) areas unless otherwise specific in the contract.
6. Overspray onto non-topsoil surfaces shall be minimized. Clean off overspray onto personal property, power poles, hydrants, utility pedestals, etc.

H. Turf Establishment Time Limits

1. Stabilize all ditch inverts with seeding, ditch checks, and erosion mats as indicated in the Plans. Erosion mats shall extend a minimum of one foot above the invert elevation on the ditch side slopes. Stabilize all ditch inverts within 3 days of the initial excavation.
2. For grading activities on slopes greater than 4:1, prior to seeding, complete dozer-tracking perpendicular to the slope to minimizing erosion. Temporarily mulch, seed and mulch, sod, or seed with erosion mat all slopes within 7 days of initial excavation or at the direction of the Engineer. Incrementally construct slope areas on an area by area basis to meet these specified turf establishment time limits.
3. Seed and mulch all non-slope and non-ditch project areas within 7 days of topsoil placement. Seed all areas within 21 days after the initial excavation. Incrementally construct restoration for non-slope and non-ditch areas on an area by area basis to meet these specified turf establishment limits.
4. In addition to the standard turf establishment time limits specified above, establish same day stabilization, seeding and/or temporary cover for critical areas. Critical areas are defined as land within 75 feet of any wetland or waters of the state, slopes greater than 3:1, or any other area identified as a critical area in the Plans.
5. The Engineer/Owner reserves the right to require daily stabilization/restoration (topsoiling, seeding, mulch, or temporary seeding and mulch) including the installation of erosion and sediment control devices for all work days after October 15th. During any time of the construction season, perform same day stabilization/restoration if a significant rainfall event is imminent.

I. Pollution Control

1. Provide OSHA approved temporary restroom facilities for use at the site. Clean and maintain restrooms regularly as needed but no less than once per week.
2. Provide methods, means, and facilities required to prevent contamination of soil, water, or air by the discharge of noxious substances from construction operations. Provide equipment and personnel to perform emergency measures required to contain any spillages of hazardous materials due to construction operations. Excavate, remove, and properly dispose of any contaminated soil, and replace excavated soil with clean compacted fill. Provide equipment and personnel to prevent harmful or hazardous substances from entering public waters. The disposal of project created wastes, effluents, chemicals, and surface waters in sanitary sewers is prohibited, unless specific permission is obtained from the sewer owner. The disposal of wastes, effluents, chemicals, or contaminated surface waters in storm sewers is prohibited. Provide systems for control of air pollutants, prevent toxic concentrations of chemicals, and prevent dispersal of toxic concentrations of pollutants into the atmosphere.

J. Removal of Erosion control Devices

1. After the site is stabilized and turf developed to the extent that future erosion is unlikely and upon approval by the engineer, remove all erosion control devices. After removal of bales and ditch checks, reshape ditches, fill sumps and trenches, dispose excess eroded material topsoil area, and fertilize and seed as necessary.

3.02 METHOD OF MEASUREMENT/BASIS OF PAYMENT

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.
- B. Payment for environmental controls shall be incidental to the work unless specifically included in the Contract items. When specific items are included in the contract, measurement and payment shall be as follows:
- C. Erosion mat is measured by the square yard, and the quantity measured for payment is the number of square yards of surface area upon which the erosion mat has been placed and accepted. No allowance is made for portions of the mat required to be entrenched in the soil for any end or junction slot or for required overlaps. The quantity is paid for at the contract unit price per square yard, which price shall be full compensation for placing and anchoring the mat including staples; for any required preparation of the seeded areas; for installing end and junction slots; for repairing and reseeding damaged areas; for furnishing and applying water; for disposal of all surplus and waste materials; and for furnishing all labor, tools, equipment and incidentals to complete the work in accordance with the Contract.
- D. Erosion bale ditch checks and alternate ditch checks are measured per lineal foot for each equivalent erosion bale installation as shown in the Plans. The quantity is paid for at the contract unit price, which shall be full compensation for placing all materials including stakes; for anchoring; for all excavation, including trenches and sumps; for any repair; for removing or spreading the accumulated sediment to form a surface suitable for seeding; for removal and disposal of all waste or surplus materials including eroded materials; for shaping and restoring ditches; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work in accordance with the Contract.
- E. Mulch is measured by the square yard, and the quantity measured for payment is the number of square yards of surface area upon which the erosion mat has been placed and accepted. The quantity is paid for at the contract unit price per square yard, which price shall be full compensation for placing and anchoring the mulch including binding, binder, or staples; for any required preparation of the seeded areas; for repairing and reseeding damaged areas; for furnishing and applying water; for disposal of all surplus and waste materials; and for furnishing all labor, tools, equipment and incidentals to complete the work in accordance with the Contract.
- F. Inlet protection is measured and paid for per each as indicated in the bid form. In absence of different types of inlet protection in the bid form, all types are paid for as inlet protection per each. Inlet protection devices shall not be eligible for payment if wrong geotextile fabric is used, or if deemed not acceptable by the Engineer.
- G. Silt fence is measured in place by the lineal foot. Measurement is along the base of the fence, center to center of end post, for each section of fence. The quantity is paid for at the contract unit price per lineal foot, which price is payment in full for erecting fence, including all excavation, placing of posts, backfilling, and attaching geotextile fabric; for any required cleaning and repairing; for removing or spreading the accumulated sediment to form a surface suitable for seeding; for the replacement of silt fence and all damages caused by overloading of sediment material or ponding of water adjacent to the silt fence; for removing the fence at completion of the project; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work in accordance with the Contract.
- H. Sediment tracking pads are measured in place and paid for per each as indicated on the bid form.

- I. Maintenance of erosion and sediment control measures is imperative and is the responsibility of the Contractor. The Owner reserves the right to make payment to Contractor for only 50 percent of quantity of erosion and sediment controls at the time of installation. The remaining payment shall be retained for assurance of maintenance and removal (as applicable) of erosion and sediment control items.

EROSION CONTROL IMPLEMENTATION PLAN (ECIP) WORKSHEET

The ECIP shall be prepared in a detailed, written and pictorial format that identifies the schedule, timing, and methodology for the contractor's implementation of the project's erosion control plan. The ECIP shall be furnished one week before the preconstruction meeting, or one week prior to commencing construction if a preconstruction meeting is not held. The ECIP shall be in accordance with and complimentary to the project erosion control plans, specifications, and report.

Project ID: _____ County: _____

Description of Project: _____

Prime Contractor: _____

Address: _____

Contact Person: _____ Phone: _____

Include the following:

1. Principal contact of the contractor responsible for installation, maintenance, and removal of erosion and sediment control best management practices (BMPs).

Name: _____

Phone: _____

Firm: _____

Address: _____

2. A description of the intended timetable and sequence of major land disturbing activities.
3. A description of erosion control and stormwater management measures to be utilized and a schedule for implementing them, including staging construction to limit disturbed areas subject to erosion; timing of erosion control mobilizations; method for winter shut-down; and the removal of temporary measures. Include the appropriate plan sheets to identify timing and/or location of BMPs.
4. A description of any additions, amendments, deletions or modifications to the project erosion control plan or any of the contract documents which pertain to erosion control and stormwater management for the project sites.
5. Site map(s) and/or annotations on the project plans including:
 - a. Boundaries of the site and areas of soil disturbance.
 - b. Location of major structural and non-structural erosion control and stormwater management practices.
 - c. Location of areas where stabilization will be employed, including but not limited to vegetation, following construction activities.
 - d. Locations where stormwater is discharged to a surface water or wetland.
 - e. Locations of any haul roads and site access points.
6. A description of selected erosion and sediment control BMPs that will be employed at the site to prevent sediments and pollutants from reaching waters of the state, including wetlands. The plan shall clearly describe the appropriate best management practice for each major activity identified and the timing during the construction process that the measures will be implemented. The description of BMPs shall include:

- a. Description of permanent or temporary erosion control and stormwater management measures. Plans shall ensure the preservation of existing vegetation where practical.
 - b. Description of structural practices to divert runoff away from exposed soils, to store flows or to otherwise limit runoff and the discharge of pollutants from the site.
 - c. Management of overland flow at the site.
 - d. Trapping of sediment in channelized flow.
 - e. Staging construction to limit disturbance of areas susceptible to erosion.
 - f. Protection of downslope drainage inlets.
 - g. Minimization of tracking at the site.
 - h. Clean up of off-site sediment deposits.
 - i. Proper disposal of building and waste material at the site.
 - j. Stabilization of drainage ways.
 - k. Installation of permanent stabilization practices as soon as possible after final grading.
7. Contractor shall submit amendments to ECIP in a written format acceptable to the Engineer if any changes to the ECIP are desired during construction. ECIP amendments shall be submitted prior to implementing changes or within 48 hours of implementation if allowed by Engineer.
8. Identification of waste site is required. If the waste site is not a licensed pit, provide the following information:
- a. Name of owner
 - b. Address and/or location description
 - c. Site plan on an aerial photo or contour map illustrating requirements of 5a through 5e.
 - d. In the case the waste site will disturb over one acre, provide proof of coverage for WDNR WPDES General Stormwater Permit for Construction Sites.

Notice: This form was developed in accordance with s. NR 216.48 Wis. Adm. Code for WPDES permittees' convenience; however, use of this specific form is voluntary. Multiple copies of this form may be made to compile the inspection report. Inspections of the construction site and implemented erosion and sediment control best management practices (BMPs) must be performed weekly and within 24 hours after a rainfall event 0.5 inches or greater.

Construction Site Name and Location (Project, Municipality, and County):		Site/Facility ID No. (FIN):	
Onsite Contact/Contractor:		Onsite Phone/Cell:	
Note: Inspection reports, along with erosion control and storm water management plans, are required to be maintained on site in accordance with s. NR 216.48 (4) and made available upon request. PLEASE PRINT LEGIBLY.			
Date of inspection:	Time of inspection: Start: <input type="radio"/> am <input type="radio"/> pm End: <input type="radio"/> am <input type="radio"/> pm	Type of inspection: <input type="radio"/> Weekly <input type="radio"/> Precipitation Event <input type="radio"/> Other (specify)	
Weather/Site Conditions: Temp. <input type="text"/> °F Antecedent Soil Moisture <input type="radio"/> Dry <input type="radio"/> Variable <input type="radio"/> Wet Last Rainfall Depth: <input type="text"/> inches Last Rainfall Date: <input type="text"/>	<input type="radio"/> Frozen or snow covered <input type="radio"/> Frozen (Thaw predicted in next week) <input type="radio"/> Melting Snow/slush	Describe current phase of construction: Scheduled Final Stabilization Date for Universal Soil Loss Equation (USLE) ¹ : Project on Schedule ² ? <input type="radio"/> Yes <input type="radio"/> No	
Name(s) of individual(s) performing inspection:		Inspector Phone/Cell:	
I certify that the information contained on this form is an accurate assessment of site conditions at the time of inspection:			
Inspector Signature		Date:	
Inspection Questions:	Yes	No (Identify Actions Required):	Location/Comments:
1. Is the erosion control plan accessible to operators?	<input type="checkbox"/>	<input type="checkbox"/> Provide onsite copy	
2. Is the permit certificate posted where visible?	<input type="checkbox"/>	<input type="checkbox"/> Post certificate	
3. Is the current phase of construction on sequence with the site-specific erosion and sediment control plan, including installation/stabilization of ponds and ditches?	<input type="checkbox"/>	<input type="checkbox"/> Add sediment control <input type="checkbox"/> Install missing ditch/pipe/pond <input type="checkbox"/> Stabilize bare soil	
4. Are all erosion and sediment control BMPs shown on plan properly installed and in functional condition?	<input type="checkbox"/>	<input type="checkbox"/> Repair <input type="checkbox"/> Modify <input type="checkbox"/> Install/Replace	
5. Is inlet protection properly installed and functioning in all inlets likely to receive runoff from the site?	<input type="checkbox"/>	<input type="checkbox"/> Clean <input type="checkbox"/> Replace <input type="checkbox"/> Install	
6. Is the air free of fugitive dust resulting from construction activity and bare soil exposure?	<input type="checkbox"/>	<input type="checkbox"/> Apply water <input type="checkbox"/> Apply dust control product	

¹ The Universal Soil Loss Equation (USLE) model and the Construction Site Soil Loss and Sediment Discharge Guidance are available at: http://dnr.wi.gov/topic/stormwater/standards/const_standards.html

² If the project is not on schedule then the soil loss summary for the project should be reviewed and schedule, plan or practices modified accordingly.

CONSTRUCTION SITE INSPECTION REPORT

Form 3400-187 (R 11/16)

Page 2 of 2

Inspection Questions:	Yes	No (Identify Actions Required):	Location/Comments:	Actions Completed by Date & Initials
7. Is the public right of way curb line free of tracked soil and accumulation?	<input type="checkbox"/>	<input type="checkbox"/> Install tracking pad <input type="checkbox"/> Widen/lengthen pad <input type="checkbox"/> Amend stone/Add geotextile <input type="checkbox"/> Install wheel washing station <input type="checkbox"/> Close entrance/exit <input type="checkbox"/> Limit traffic across disturbed areas <input type="checkbox"/> Sweep road and curb line		
8. Are wetlands, lakes, streams, ditches, or storm sewers downstream of the site free of sedimentation and turbid water leaving the site? ³	<input type="checkbox"/>	<input type="checkbox"/> Repair/Replace erosion control <input type="checkbox"/> Add sediment controls <input type="checkbox"/> Modify operations <input type="checkbox"/> Contact DNR to verify extent of cleanup required		
9. Is dewatering and/or vehicle and equipment washing being done in a manner that prevents erosion and sediment discharge?	<input type="checkbox"/>	<input type="checkbox"/> Install treatment train <input type="checkbox"/> Install energy dissipation <input type="checkbox"/> Modify discharge location <input type="checkbox"/> Modify intake to reduce sediment		
10. Are soil stockpiles existing for more than 7 days covered and stabilized?	<input type="checkbox"/>	<input type="checkbox"/> Seed <input type="checkbox"/> Install mat/mulch/polymer <input type="checkbox"/> Cover with tarp/plastic sheeting		
11. Are downstream channels and other downhill areas protected from scour and erosion?	<input type="checkbox"/>	<input type="checkbox"/> Install energy dissipation at outfall <input type="checkbox"/> Install ditch checks <input type="checkbox"/> Install slope interruption <input type="checkbox"/> Install onsite detention		
12. Are good housekeeping practices or treatment controls in place to prevent the discharge of chemicals, cement, trash, and other materials into wetlands, waterways, storm sewers, ditches, or drainage-ways? ⁴	<input type="checkbox"/>	<input type="checkbox"/> Properly dispose of trash <input type="checkbox"/> Provide concrete washout station <input type="checkbox"/> Contact DNR to verify extent of cleanup required		
13. Is the plan reflective of current site operations and does it address all erosion and sediment control issues identified during the inspection?	<input type="checkbox"/>	<input type="checkbox"/> Revise sequence <input type="checkbox"/> Revise sediment control BMP <input type="checkbox"/> Revise erosion control BMP <input type="checkbox"/> Revise post-construction storm water BMP		
14. Are all areas where construction has temporarily ceased (and will not resume for more than 2 weeks) temporarily stabilized?	<input type="checkbox"/>	<input type="checkbox"/> Topsoil & seed <input type="checkbox"/> Install mat/mulch/polymer <input type="checkbox"/> Cover with tarp/plastic sheeting		
15. Are all areas at final grade permanently vegetated or stabilized with other treatments?	<input type="checkbox"/>	<input type="checkbox"/> Topsoil & seed <input type="checkbox"/> Install mat/mulch/polymer <input type="checkbox"/> Sod <input type="checkbox"/> Install stone base		
16. Have temporary sediment controls been removed in areas of the site that meet the permit definition of 'final stabilization'?	<input type="checkbox"/>	<input type="checkbox"/> Water to establish vegetation <input type="checkbox"/> Repair or reseed areas <input type="checkbox"/> Remove temporary practices		

³ If sediment discharge enters a wetland or waterbody, the permittee should consult with DNR staff to determine if sediment cleanup and/or additional control measures are required.

⁴ The permittee shall notify the DNR immediately via the spills hotline at (800)943-0003 of any release or spill of a hazardous substance to the environment in accordance with s. 292.11, Wis. Stats., and ch. NR 706, Wis. Adm. Code.

END OF SECTION 31 25 00

SECTION 31 32 19 GEOSYNTHETIC STABILIZATION, SEPARATION, AND DRAINAGE FABRICS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section describes furnishing and installing geotextile fabrics for subgrade separation and stabilization, drainage filtration, subgrade reinforcement, and under culverts and riprap.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Furnish geotextile fabric of either woven or nonwoven polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride. All fabric will have the minimum strength values in the weakest primary direction. Use nonwoven fabric that is one or a combination of the following: needle punched, heat bonded, or resin bonded.
- B. Furnish geotextile fabric that is insect, rodent, mildew, and rot resistant.
- C. Furnish the geotextile fabric in a wrapping that protects the fabric from ultraviolet radiation and from abrasion due to shipping and hauling. Keep the geotextile dry until finished.
- D. Clearly mark the geotextile fabric rolls to show the type of fabric.
- E. The Engineer may obtain samples of fabric for testing from the job site as specified below, or as the Engineer determines.
- F. If using sewn seams, furnish a field sewn seam sample produced from the geotextile fabric and thread and with the equipment proposing to use on the project, before incorporating into the work.

2.02 GEOTEXTILE FABRIC, TYPES SAS (SUBGRADE AGGREGATE SEPARATION), DF (DRAINAGE FILTRATION), R (RIPRAP), AND HR (HEAVY RIPRAP)

- A. Furnish fabric (Type as called out on the Bid Form) conforming to the physical properties for Types SAS, DF (Schedule A, B or C), R, and/or HR, as appropriate, specified in Section 645.2 of the State of Wisconsin Standard Specifications for Highway and Structure Construction, current edition.
- B. Provide product samples (including sewed samples as applicable) and manufacturer's certified report of test/analysis showing compliance when requested by the Engineer.

PART 3 - EXECUTION

3.01 CONSTRUCTION METHODS

- A. Sewing
 - 1. Sew all factory and field seams with a thread having the same or greater durability as the fabric material. Use a 401 stitch conforming to Federal Standard No. 751a for all seams. Ensure that all seams develop a tensile strength equal to or greater than 60 percent of the specified grab tensile strength of the fabric, unless specified above.

B. Geotextile Fabric, Type SAS (Subgrade Aggregate Separation)

1. Before placing the geotextile fabric, smooth, shape, and compact the subgrade to the required grade, section, and density. After placing the fabric on the subgrade area, do not allow traffic or construction equipment to travel directly on the fabric.
2. Roll the fabric out on the roadway and pull taut manually to remove wrinkles. Join separate pieces of fabric by overlapping or sewing. Place the fabric in the overlapped joints so it overlaps at least 18 inches (450 mm).
3. Use of weights or pins, if necessary, to prevent the wind from lifting the fabric.
4. After placing, do not expose the fabric longer than 48 hours before covering.
5. Place the base material over the fabric by back dumping with trucks and leveling with a crawler dozer. Do not use construction equipment that causes ruts deeper than 3 inches (75 mm). Fill all ruts with additional material. Do not smooth ruts without adding additional material. Cover damaged areas with a patch of fabric using a 3-foot (900 mm) overlap in all directions.

C. Geotextile Fabric, Type DF (Drainage Filtration)

1. Before placing the geotextile fabric in trench drains, construct the trench to the grades and dimensions the plans show or as the Engineer directs. Remove protruding stones and other matter that might damage the geotextile fabric from the trench walls and base before placing the fabric. Place the geotextile fabric in the trench so it conforms to the trench walls and remains in proper position during drain construction and backfilling. The Contractor may join separate pieces of fabric by overlapping or sewing. If overlapping, place the fabric in overlap joints of at least 18 inches (450 mm) in the direction of drain flow. Correct misaligned fabric as the Engineer directs. Treat damaged fabric areas by one of the following methods:
 - a. Place an additional section of fabric extending at least 24 inches (600 mm) beyond any point of the damaged area and position between the trench walls and the damaged fabric.
 - b. Remove the section of fabric containing the damaged area and replace it with a new section of fabric.
2. For applications other than trench drains, construct the surface on which placing the fabric to the grades and dimensions the plans show. Prepare the surface by removing or covering all objects that might damage the fabric. Carefully place the fabric to prevent damage and secure in position. Conduct backfilling or covering operations so that no damage or misalignment occurs to the fabric. Treat all fabric damage or misalignment as specified in the previous paragraph.
3. After placement, do not expose the fabric longer than 48 hours before covering or backfilling.

D. Geotextile Fabric, Type R (Riprap)

1. Before placing the fabric, grade the area smooth and remove all stones, roots, sticks, or other matter that might prevent the fabric from completely contacting the soil.

2. Place the fabric loosely and lay it parallel to the direction of water movement. The Engineer may require pinning or stapling to hold the geotextile in place. Join separate pieces of fabric by overlapping or sewing. Overlap the fabric in the joints at least 24 inches (600 mm) in the direction of flow. After placing, do not expose the fabric longer than 48 hours before covering.
3. Cover damaged areas with a patch of fabric that overlaps 3-feet (900 mm) in all directions.
4. Place riprap from the base of the slope upward. The freefall height of riprap must not exceed one foot (300 mm).

E. Geotextile Fabric, Type HR (Heavy Riprap)

1. Place as specified above for Type R, except that the freefall height of the riprap must not exceed 6 inches (150 mm).

3.02 METHOD OF MEASUREMENT/BASIS OF PAYMENT

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.
- B. Measure the geotextile fabric bid items by the square yard acceptably completed.
- C. Payment for Geotextile Fabric (Type) is full compensation for preparing the subgrade material, providing, transporting, and installing the fabric.
- D. In the event there are no bid items for geotextile fabric(s) that are called out in the plans, or specified in these specifications (such as Type R or HR fabric being required for riprap) or special provisions, then the furnishing and installing such fabric(s) is considered incidental to associated bid items.

END OF SECTION 31 23 19

SECTION 32 11 16 SUBBASE COURSES

PART 1 - GENERAL

1.01 SUMMARY

- A. This work consists of the construction of a foundation course of granular material of designated quality on the prepared roadbed in reasonably close conformity with the lines, grades and sections shown on the plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The material furnished and used in the work shall consist of natural sand or a mixture of sand with gravel, crushed gravel, crushed stone or other broken fragmented material, and shall conform to Section 350 and 209 of the State of Wisconsin Standard Specifications for Highway and Structure Construction, current edition.
- B. Use either Grade 1 or Grade 2 material, unless a specific grade is called out in the bid form or special provisions.
- C. Material Testing Frequency
 - 1. Provide one gradation test for the first 500 cubic yards, followed by one gradation test per every 3,000 cubic yards thereafter.
- D. Source
 - 2. Except as provided below for materials utilized from the project excavation, import subbase from commercial suppliers or borrow pits.
- E. Rights in the Use of Materials Found on the Project
 - 3. The Contractor, with the written approval of the Engineer, may use on the project such stone, gravel, sand or other material determined suitable by the Engineer, as may be found in the excavation and will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used. Replace, at the Contractor's own expense, such material with other acceptable material all of that portion of the excavation material so removed and used which was needed for use in the embankments, backfills, approaches, or otherwise. Do not excavate or remove any material from within the project site which is not within the excavation limits as indicated by the slope and grade lines, without written authorization from the Engineer.

2.02 EQUIPMENT

- A. Provide equipment and tools necessary for producing, handling, hauling and placing of the granular subbase course and for performing and maintaining all parts of the work, satisfactory as to design, capacity and mechanical condition for the purpose intended, on the job before the work is started. Repair, improve, replace or supplement any equipment which is not maintained in full working order or

which, as used by the Contractor, is inadequate to obtain the results prescribed, to obtain the progress and quality contemplated by the contract.

2.03 NONCONFORMING MATERIALS

- A. Engineer may allow non-conforming materials to remain in place if found to be noncompliant with this specification after the material is placed. In such a case a price reduction as specified below shall be applied. Only one price adjustment will be applied to a given quantity of material. If the quantity in question is subject to more than one of the following adjustment conditions, then apply the adjustment with the greater price reduction.

Gradation:

≤ 3% out on any sieve	5% price reduction
> 3% to ≤ 5% out on any sieve	20% price reduction
> 5% out on any sieve	Remove and Replace or 40% price reduction

Plasticity:

Nonconformance identified before placement	nonconforming material must not be used
Nonconformance identified after placement	remove and replace or 50% price reduction

PART 3 - EXECUTION

3.01 SUBGRADE

- A. Prepared and maintain the subgrade upon which the subbase course is to be constructed to the required lines, grades, and section as shown in the Plans and as follows.
- B. Do not place materials on a subgrade covered by ice or snow, or on a wet or soft subgrade, unless specifically directed.
- C. Do not place subbase material on soft, yielding, or spongy subgrade. Excavate and backfill areas of soft, yielding, or spongy subgrade or otherwise treated as directed by the Engineer. If unacceptable stability is caused by excessive moisture, allow the materials to dry prior to compacting. When necessary, accelerate drying of such materials by aeration or manipulation by means of blade graders, harrows, discs or other appropriate equipment.
- D. If request by Engineer to remove and replace yielding subgrade, excavation or backfill performed will be measured and paid for under pertinent contract items.
- E. Do not place subbase material on a dusty subgrade where resulting conditions might cause contamination of the material or preclude utilization of the entire subbase for its intended purpose.
- F. Placing
 - 1. Place subbase course material upon the prepared subgrade in a manner to avoid as much as possible contamination of the course with soil or other foreign material.
 - 2. Compact the material in accordance with the provisions of Section 312300. Standard compaction shall be applicable to this work, unless special compaction, as outlined in Section 312300, is specifically required by the plans or special provisions.

G. Shaping and Compacting

1. Provide motor graders or subgrade finishing machines used for shaping the subbase course of adequate design and have sufficient power to satisfactorily perform the shaping operations.
2. Provide compacting equipment of the static type or of the vibrating type, or both, and of a design and have sufficient mass or force to accomplish the requirements hereinafter set forth.
3. Perform leveling, smoothing and compaction operations shall progress with the placing of the material and, to the extent possible, the same day in which the subbase course material is placed. Shape and trim the completed course to the lines, grades and section called for on the plans or in the contract and so maintained, insofar as practical, during the life of the contract.
4. Remove and dispose rocks and other fragments in excess of the permitted maximum size.
5. Do not place loam, clay, silt, topsoil, or other earthy materials of a similar character on the surface or incorporated in the subbase course in order to expedite hauling, to carry traffic or for any other reason.

3.02 METHOD OF MEASUREMENT/BASIS OF PAYMENT

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.
- B. Method of Measurement
- C. The item of Granular Subbase is measured, as provided in the contract, by the cubic yard, by the ton or by the square yard (inch thickness) in place.
- D. Where the cubic yard measurement is used, the granular subbase course material is measured in cubic yards of volume in its original position computed by the method of average end areas, with no correction for curvature or, if the Engineer elects, by the method of truncated prisms. Measurements will be taken after the necessary stripping or other preparation of the deposit has been performed. Notify the Engineer sufficiently in advance of beginning the removal of granular subbase course material to afford the Engineer sufficient time to make the necessary original measurements. No measurement or payment for any material removed prior to making such measurements will be completed.
- E. Where the cubic yard measurement is used and where the quantity of granular subbase to be placed is of such a minor amount that, in the judgment of the Engineer, the measurement of such minor quantity by the above method would be impractical, the measurement may be made by the cubic yard in the vehicle. The capacity of each vehicle used for hauling the material will be determined by the Engineer. Such capacity will be determined to the nearest 0.1 cubic yard.
- F. Subbase course materials measured by the ton, which contain total moisture in excess of seven percent when weighed, will have deducted from their measured mass, the mass of the moisture in excess of seven percent. The Engineer will determine the moisture content of the materials at such intervals as the Engineer deems expedient for proper determination. Determination of the moisture content of the materials will be based on and expressed as a percent of the dry mass of

the materials. Furnish and deliver to the Engineer with each load a ticket showing the net mass of the load.

- G. When the contract so provides, granular subbase course will be measured by the square yard of area in place for the finished thickness called for in the contract or ordered by the Engineer. For a subbase course with sloping sides, the computation of the square yards in place will be based on the mean width of the top and bottom of the course. Subbase course for side roads, private entrances and other miscellaneous areas will be measured similarly for payment.
- H. Where subbase course is measured by the square yard in place, any addition ordered to correct for settlement of the earth subgrade will be measured on the basis of the in-place volume of such additions, converted to equivalent square yards.

I. Basis of Payment

- 1. The quantity of granular material, measured as provided above, will be paid for at the contract unit price per cubic yard, per ton or per square yard (inch thickness), for granular subbase, complete in place. That price shall be full compensation for furnishing, unless otherwise provided, excavating, loading, hauling, placing, shaping, watering and dust abatement, compacting, finishing and maintaining the granular subbase material, salvaging, and for all labor, tools, equipment and incidentals necessary to complete the work.

END OF SECTION 32 11 16

SECTION 32 11 23 AGGREGATE BASE COURSES

PART 1 - GENERAL

1.01 SUMMARY

- A. Use base course consisting of densely compacted sand and gravel composed of one or more courses or layers of coarse aggregate. Use either crushed gravel or crushed concrete or crushed stone or crushed asphaltic pavement along with fine aggregate and binder or filler. Blend as necessary to produce an intimate mixture of the required gradation and stability, constructed on the prepared foundation in accordance with the specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross-sections shown on the plans or established by the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Base Aggregate Dense (3-inch, 1 ¼-inch, ¾-inch) will comply with the material requirements of Sections 301 and 305 of the State of Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction, current edition.
- B. Material Testing Frequency
 - 1. Provide one gradation test required for the first 500 cubic yards, followed by one gradation test per every 3,000 cubic yards thereafter.

2.02 NON-CONFORMING MATERIALS

- A. For materials placed and incorporated into the work and then found or determined to not meet this specification, the Engineer may after carefully evaluating the situation, including appropriate tests/results, allow non-conforming materials to remain in place and apply a price reduction. Only one price adjustment will be applied to a given quantity of material. If the quantity in question is subject to more than one of the following conditions, apply the adjustment with the greater price reduction listed below:

Gradation ⁽¹⁾:

≤ 3% out on any sieve	5% price reduction
> 3% to ≤ 5% out on any sieve	20% price reduction
> 5% out on any sieve	remove & replace, or 40% price reduction

⁽¹⁾ Do not apply these price reduction guidelines to Base Aggregate Dense, 3-Inch material (non-conforming 3-inch material, due to gradation, must be removed and replaced).

Fracture:

≤ 5% out of specification	5% price reduction
> 5% to ≤ 10% out of specification	20% price reduction
> 10% out of specification	remove & replace, or 40% price reduction

Wear, Soundness, Freeze-Thaw, or Plasticity:

For non-conformance of any degree	remove and replace, or 50% price reduction
-----------------------------------	--

PART 3 – EXECUTION

3.01 CONSTRUCTION

- A. Construct base course to the width and section shown on the plans.

- B. Foundation Preparation
 - 1. Prepare the foundation, or resurface the previously placed base layer, as specified below, before placing base. Do not place base on foundations that are soft, spongy, or covered by ice or snow. Do not place base on frozen foundations unless the engineer approves otherwise. Water and rework or re-compact dry foundations as necessary to ensure proper compaction, or as the engineer directs.
 - 2. Prepare and construct the foundation to uniform density throughout. Construct the foundation to the required alignment and cross-section with equipment and methods adapted for the purpose. After shaping and compacting, provide a smooth foundation, at required density, and at the proper elevation and contour, to receive the next course.
 - 3. If necessary to properly accomplish blading or to eliminate or prevent conditions of non-uniform stability or density, scarify the area forming the foundation to a uniform depth.
 - 4. Unless specified otherwise, fill all holes, ruts, and other depressions in the foundation with materials similar to those existing in the foundation. Excavate and remove high places to the required lines, grade, and section.
 - 5. Excavate and backfill areas of yielding or unstable materials with the material the engineer directs.
 - 6. Prepare the foundation to conform to the specifications for the specific subbase, base, or surface course constructed.
 - 7. If the foundation is an earth subgrade, constructed under this contract or under a previous contract, prepare or restore the foundation by removing all vegetation; excavating and removing materials of any nature encountered above the required elevations; filling all depressions occurring below the required elevations; and smoothing, shaping, and compacting the subgrade to the required grade, section, and density.
 - 8. If the earth subgrade construction was substantially completed under a previous contract, do not presume that the previously completed work conforms to the requirements under this section.

- C. Compacted Thickness
 - 1. Do not exceed the maximum compacted thickness 6 inches for any one layer. The maximum thickness may be exceeded if a layer is placed upon a loose sand subgrade which would otherwise displace or when vibrating or a combination of vibratory and static compaction equipment is used, the compacted depth of a single layer of the base course may be increased to 8 inches upon approval of the Engineer, or when constructing base course 3-inch, a maximum compacted layer thickness of 9 inches is allowed.

2. The work in general will proceed from the point on the project nearest the source of supply of the aggregate so the hauling equipment will travel over the previously placed material, and the hauling equipment routed as uniformly as possible over all portions of the previously constructed courses or layers of the base course.
3. Deposit material on the foundation or previously placed layer in a manner to minimize segregation and to facilitate spreading in a uniform layer of the required dimensions. If blending of materials is necessary to provide the required gradation and properties of the material, and is permitted to be done on the site, accomplish the blending by intermixing the aggregate and blending material by means of motor graders, discs, harrows or other equipment to produce a uniform distribution or gradation throughout the finished mixture. Avoid excessive manipulation or mixing which will cause segregation between the coarse and fine materials.
4. Compact a layer or course after it has been placed and spread to the required thickness, width and contour. Moisten material deficient in moisture content for readily attaining the required density to the degree necessary during compaction operations by means of approved equipment.
5. Unless otherwise required in the contract, compact each layer to the requirements for standard compaction.
6. When special compaction is specifically required by the Plans or special provisions, compact each layer to at least 95 percent of maximum density before the succeeding layer is placed. Determination of optimum moisture content and maximum density will be in accordance with AASHTO T 99, Method C (standard proctor), with replacement of the fraction of the aggregate retained on the 3/4 inch sieve with P-3/4 inch/R-4 material. Field determination of the density for special compaction of the completed base course will be in accordance with AASHTO T 191 or AASHTO T 238 for determining density of soil in place.
7. Rework all areas where required compaction is not obtained as necessary or deficient material removed and replaced with material that will yield the required results.
8. Prior to and during compaction operations, shape and maintain the material to the required dimensions and contour (to within 0.04 feet of the plan elevation) by motor graders or other suitable equipment. Keep the surface of each layer true and smooth at all times.

D. Base as Foundation for Concrete Pavement

1. Prepare the foundation for concrete pavement by restoring, preparing, and conditioning of unstabilized bases according to the requirements below for application by form or slip form methods.
2. For areas of the foundation that are impractical to prepare by machine methods, prepare these areas by hand methods satisfactory to the engineer.
3. Ensure that the foundation in all cases is in a moist but not saturated condition during concrete placement. Saturate the foundation with water, if required, not less than 6 hours before placing the concrete. If the foundation subsequently dries, moisten it by sprinkling water just before placing the concrete. Sprinkle the water to avoid forming pools.

4. Trim and shape the foundation for a concrete base or pavement for a width equal to the width of the intended pavement plus at least one foot on each side to approximately the required lines, grade, and cross-section; and then uniformly compact to the required density. Perform compaction with suitable rolling or other types of consolidating equipment. Unless specified otherwise, uniformly compact the foundation to not less than the density for standard compaction of earth subgrade, subbase, or base.
5. Complete preparing the foundation for at least 300 feet in advance of depositing concrete, unless the engineer allows otherwise.
6. Trim and smooth ruts and irregularities in the foundation surface caused by trucks or other equipment hauling aggregates. Compact these ruts and irregularities ahead of concrete placing operations. Excavate, fill with suitable material, and compact soft and yielding spots.

E. Constructing Shoulders

1. Construct base course of shoulders adjacent to pavement.
2. Construct the shoulders with base course material to conform to the elevation and typical section shown on the Plans, except for minor modifications which may be required to meet other work.
3. Perform the work in the proper sequence with surfacing or paving operations as hereinafter provided.
4. Use equipment in shouldering operations adequate in design and capacity to accomplish the required results and is subject to approval by the Engineer. Do not use equipment which by its design or its manner of operation will damage or mar the pavement or surfacing, curbs or appurtenances.
5. Insofar as practicable, place base course material directly on the shoulder area between the pavement edge and the outer shouldering limits indicated on the typical section. Recover uncontaminated material deposited outside the limits and place within the limits. If misplaced material is not recovered and placed on the shoulder, or becomes contaminated, deductions may be made for the estimated quantity of unrecovered or contaminated material, as determined by the Engineer.
6. Do not place shoulder material on the pavement or surfacing during placing, unless specifically permitted by the Engineer, and if so permitted, must not remain on the pavement overnight.
7. Spread and compact base course material as placed to the required density in layers not exceeding 6 inches in compacted thickness. Perform necessary shaping during compacting operations so the resulting finished shoulder will conform to the required grade, slope and section. Broom off all littering of the pavement or surfacing with base material.

F. Shoulders Adjacent to Concrete Pavement

1. Complete construction of shoulders along concrete pavements in such a manner that the shoulder construction will be completed to approximate grade and cross section on each separate section of pavement as soon as such section has cured sufficiently to withstand hauling

and placing operations. For the above purpose each daily pour of concrete is considered a section of pavement.

G. Shoulder Adjacent to Asphaltic Surfaces

1. Complete construction of aggregate shoulders along asphaltic pavements including paved shoulders open to through traffic and where any wedge or course, or any combination thereof is 2 inches or more in thickness or where the thickness of such course plus the depth of the existing drop-off at the pavement edge including paved shoulders is 2 inches or more, in a manner that the shoulder is constructed to the required cross section and flush with the surface of the placed asphaltic surfacing including paved shoulders within 48 hours following the placing of such asphaltic work. Provide and maintain low shoulder or pavement drop off signing and other traffic protection and control devices through such low shoulder areas until the shoulder is constructed to the required cross section and flush with the surfacing.

H. Maintenance

1. Maintain the base course until accepted.

I. Dust Abatement

1. Minimize the dispersion of dust from the base course, including shoulders, during construction and maintenance operations by the application of water or other approved dust control materials as provided in the contract or required by the Engineer.

J. Stockpiles

1. Under the item of base course, the right is reserved to order approximately five percent of the quantities bid upon placed in stockpiles within the limits of the right of way or project site at locations designated by the Engineer.
2. Clear and prepare the area to be covered by each stockpile to facilitate the recovery of the maximum amount of stockpiled material. Shape and trim stockpiles present a neat appearance.

3.02 METHOD OF MEASUREMENT

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.
- B. The item base course is measured as provided in the contract by the ton, in the vehicle by the cubic yard or in-place and compacted by the square yard. The quantity measured for payment is the amount of material required and incorporated in the work or placed in stockpiles in accordance with the contract.
- C. Aggregates, measured by the ton, obtained from wet pits or which contain total moisture in excess of seven percent, unless stockpiled, aerated or dried to reduce the moisture content to seven percent or less before being weighed, will have moisture content in excess of seven percent deducted from the measured mass. Determination of the moisture content of the aggregates will be based on and expressed as a percent of the dry mass of the aggregates.

- D. When aggregates are measured by the ton, furnish and deliver to the Engineer a ticket with each load showing the net mass of the load, the type of material, the date and project where used.
- E. For material measured by the square yard, the Engineer will only measure areas placed to the thickness the contract specifies or the Engineer directs. For subbase with sloping sides, the Engineer will compute area based on the mean width of the top and bottom of the layer. The Engineer will measure additions ordered to correct for settlement of the earth subgrade based on the in-place volume converted to an equivalent area.

3.03 ALTERNATE MEASUREMENT PROCEDURES

A. Conversion of Mass to Volume

- 1. In lieu of measuring the aggregate items by volume in the vehicle at the point of delivery, the cubic yard measurement may be obtained by weighing the material and converting the mass into cubic yards.
- 2. At least once during each regular production day, select, weigh, and haul a load of material to a point of delivery representative of the day's production, and then measure by volume in the vehicle. The mass-volume factor thus determined will be used to convert the day's accepted weighed production into cubic yards.

B. Conversion of Volume to Mass

- 1. In lieu of weighing minor amounts of aggregate items, the ton measurement may be obtained by measuring the material by volume in the vehicle at the point of delivery and converting the volume into tons. For the purpose of this procedure, a minor amount will be 1000 tons or less.
- 2. At least once during each regular production day, select and haul a load of material to a point of delivery representative of the day's production, measure in the vehicle and haul to an approved scale and weigh. The volume-weight factor thus determined will be used to convert the day's accepted production of such minor amount into tons. The frequency of determining such factor may be revised if deemed desirable by the Engineer. Deductions will be made for moisture content as provided.

3.04 BASIS OF PAYMENT

- A. The quantity of aggregate or pre-mixed aggregate and blended filler material for base course, measured as provided above, will be paid for at the contract unit price per ton or per cubic yard in the vehicle, or by the square yard (inch thickness) complete in place, which prices are full compensation for furnishing, producing, crushing, screening, loading, hauling, placing, watering unless otherwise provided, drying and compacting; for maintaining; for preparing foundation for dust abatement, unless otherwise provided; for stockpiling, if required; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.
- B. Engineer may deduct the quantity of base placed outside the lines or grades required by the Plans, unless placed at Engineer's direction.
- C. Should excavation below subgrade (EBS) be required in an area of completed base construction, the excavation (including excavating the base) will be measured and paid for as Excavation Common. Stockpiling, respreading, compacting and shaping of the base to the plan grade and cross-section in the area of EBS will be considered incidental.

END OF SECTION 32 11 23

SECTION 32 12 16 ASPHALT PAVING

PART 1 - GENERAL

1.01. SUMMARY

- A. This specification follows the WisDOT Standard Specifications. For projects using this specification that do not involve WisDOT funding, certain testing requirements will not be required. For example, obtaining asphalt samples and shipping them to the Madison Lab of the WisDOT will not be required. The supplier and Contractor will still provide a certification that the materials are in full compliance with the specifications herein. In lieu of such certification, the supplier may provide documentation that the same materials are being used on a WisDOT project being completed in the region at the same time of the non-WisDOT funded project.
- B. Work described herein includes requirements common to plant mixed asphaltic bases and pavements, asphaltic materials including asphaltic binders, cements, cut-back asphalts, emulsified asphalts, and similar products. This section also describes applying tack coat, HMA mixture design, providing and maintaining a quality management program for HMA mixtures, and constructing HMA pavement. This section also describes constructing safety islands, curb, rumble strip, flumes, and asphaltic surface for patching, detours, and temporary construction.

PART 2 - PRODUCTS

2.01 ACRONYMS AND DEFINITIONS

- A. Interpret materials related acronyms used as follows:
 - 1. **CMM** Construction and material manual, published by WisDOT
 - 2. **FRAP** Fractioned reclaimed asphaltic pavement
 - 3. **HMA** Hot mix asphalt
 - 4. **JMF** Job mix formula
 - 5. **PG** Performance graded
 - 6. **RAP** Reclaimed asphaltic pavement
 - 7. **RAS** Recycled asphalt shingles
 - 8. **SMA** Stone matrix asphalt
 - 9. **VMA** Voids in mineral aggregate
 - 10. **WMA** Warm mix asphalt
- B. Interpret materials related definitions used as follows:
 - 1. **Additive** A material blended with asphaltic binder or aggregate to enhance the characteristics of the final HMA blend, but that does not alter the binder performance grade.
 - 2. **Asphaltic binder** The predominant asphalt cement in HMA.
 - 3. **Filler** Mineral fillers, used primarily to fill voids between aggregate particles to meet gradation requirements.
 - 4. **Fractionated reclaimed asphaltic pavement** Reclaimed asphalt pavement processed by screening and separating by maximum and minimum particle size, asphalt content, asphalt performance grade, and aggregate characteristics.
 - 5. **Leveling layer** A thin HMA layer placed to eliminate irregularities in the profile or thickness of underlying pavement layers.

6. **Lower layer** An asphaltic pavement layer below the upper layer in the completed pavement structure. There may be multiple lower layers.
7. **Modifier** A material blended with the asphaltic binder to enhance its characteristics by modifying the performance grade of the binder.
8. **Reclaimed asphalt pavement** Material resulting from cold milling or crushing existing asphaltic pavement.
9. **Recycled asphalt shingles** Waste material from a shingle manufacturing facility, either new or used material salvaged from residential roofing operations, or any combination of these materials ground to ensure that 100 percent will pass a 3/8 sieve and processed to remove deleterious material.
10. **Upper layer** The top asphaltic pavement layer in direct contact with traffic in the completed pavement structure. There is only one upper layer.
11. **Warm mix asphalt** Asphaltic mixture containing a warm mix additive or using a warm mix process that reduces the mixing and compaction temperatures typically required for that application.
12. **Wedging** A tapered layer of asphaltic pavement used to build up an existing surface. Wedging layers may be thicker or thinner than standard pavement layers.

2.02 AGGREGATE SAMPLING AND TESTING

- A. The Owner, Owner's representative and the Contractor will sample and test, when required, according to the following methods, except as revised with the Engineer's approval:
 1. Sampling aggregates AASHTO T2
 2. Material finer than No. 200 sieve AASHTO T11
 3. Sieve analysis of aggregates AASHTO T27
 4. Mechanical analysis of extracted aggregate AASHTO T30
 5. Sieve analysis of mineral filler AASHTO T37
 6. Los Angeles abrasion of coarse aggregate AASHTO T96
 7. Freeze-thaw soundness of coarse aggregate AASHTO T103
 8. Sodium sulfate soundness of aggregates (R-4, 5 cycles) AASHTO T104
 9. Extraction of bitumen AASHTO T164
- B. Furnish asphalt material conforming to Section 455.2 of the WisDOT Specifications.
- C. Furnish aggregates for the asphalt mixture conforming to Section 460.2 of the WisDOT Specifications.

2.03 AGGREGATE GRADATION MASTER RANGE AND VMA REQUIREMENTS

TABLE 460-1 AGGREGATE GRADATION MASTER RANGE AND VMA REQUIREMENTS

SIEVE	PERCENT PASSING DESIGNATED SIEVES						
	NOMINAL SIZE						
	No.1 (37.5mm)	No.2 (25.0 mm)	No.3 (19.0mm)	No.4 (12.5mm)	No.5 (9.5mm)	SMA No. 4 (12.5 mm)	SMA No. 5 (9.5 mm)
50.0-mm	100						
37.5-mm	90 –100	100					
25.0-mm	90 max	90 -100	100				
19.0-mm	___	90 max	90 -100	100		100	
12.5-mm	___	___	90 max	90 -100	100	90 - 97	100
9.5-mm	___	___	___	90 max	90 -100	58 - 72	90 - 100
4.75-mm	___	___	___	___	90 max	25 - 35	35 - 45
2.36-mm	15 – 41	19 - 45	23 - 49	28 - 58	32 - 67	15 - 25	18 - 28
75-µm	0 – 6.0	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	8.0 - 12.0	10.0 - 14.0
% MINIMUM VMA	11.0	12.0	13.0	14.0 ^[1]	15.0 ^[2]	16.0	17.0

^[1] 14.5 for LT and MT mixes.

^[2] 15.5 for LT and MT mixes.

A. Asphaltic Binders

1. The plans will identify the grade of asphaltic binder in the HMA Pavement item on the typical sections, in the general notes on the plans, or in the individual bid items.

B. Additives

1. *Hydrated Lime Antistripping Agent*
If used in HMA mixtures, furnish hydrated lime conforming to [ASTM C977](#) and containing no more than 8 percent un-hydrated oxides. Percent added is by weight of the total dry aggregate.
2. *Liquid Antistripping Agent*
If used in HMA mixtures, add liquid antistripping agent to the asphaltic binder before introducing the binder into the mixture. Provide documentation indicating that addition of liquid antistripping agent will not alter the characteristics of the original asphaltic binder performance grade (PG).
3. *Stone Matrix Asphalt Stabilizer*
Add an organic fiber, an inorganic fiber, a polymer-plastic, a polymer-elastomer, or approved alternate stabilizer to all SMA mixtures. Use a single additive system for all SMA pavement in the contract.
4. *Warm Mix Asphalt Additive or Process*
Use additives or processes from the department's approved products list. Follow supplier or manufacturer recommendations for additives and processes when producing WMA mixtures.

5. *Recycled Asphaltic Materials*

The Contractor may use recycled asphaltic materials from FRAP, RAP, and RAS in HMA mixtures. Stockpile recycled materials separately from virgin materials and list each as individual JMF components.

Control recycled materials used in HMA by evaluating the percent binder replacement, the ratio of recovered binder to the total binder. Conform to the following:

MAXIMUM ALLOWABLE PERCENT BINDER REPLACEMENT

<u>Recycled Asphaltic Material</u>	<u>Lower Layers</u>	<u>Upper Layer</u>
RAS if used alone	25	20
RAP and FRAP in any combination	40	25
RAS, RAP, and FRAP in combination ^[1]	35	25

^[1] When used in combination, the RAS component cannot exceed 5 percent of the total weight of the aggregate blend.

6. *Recovered Asphaltic Binders*

Establish the percent of recovered asphaltic binder from FRAP, RAP, and RAS for the mixture design according to AASHTO T164 using the appropriate dust correction procedure. If production test results indicate a change in the percent of recovered asphaltic binder, the Contractor or the Engineer may request a change in the design recovered asphaltic binder.

The Contractor may replace virgin binder with recovered binder up to the maximum percentage allowed under 460.2 without changing the asphaltic binder grade. If using more than the maximum allowed under 460.2, furnish test results indicating that the resultant binder meets the grade the contract originally specified.

2.04 HMA MIXTURE DESIGN

- A. For each HMA mixture type used under the contract, develop and submit an asphaltic mixture design according to CMM 8-66 and conforming to the requirements of Table 460-1 and Table 460-2. The values listed are design limits; production values may exceed those limits.

TABLE 460-2 MIXTURE REQUIREMENTS

Mixture type	LT	MT	HT	SMA
ESALs x 106 (20 yr design life)	<2.0	2 - <8	>8	> 5 mil
LA Wear (AASHTO T96) 100 revolutions(max % loss) 500 revolutions(max % loss)	1350	13 45	13 45	13 40
Soundness (AASHTO T104) (sodium sulfate, max % loss)	12	12	12	12
Freeze/Thaw (AASHTO T103) (specified counties, max % loss)	18	18	18	18
Fractured Faces (ASTM D5821) (one face/2 face, % by count)	65/ ___	75 / 60	98 / 90	100/90
Flat & Elongated (ASTM D4791) (max %, by weight)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	20 (3:1 ratio)
Fine Aggregate Angularity (AASHTO T304, method A, min)	40	43	45	45
Sand Equivalency (AASHTO T176, min)	40	40	45	50
Gyratory Compaction Gyration for Nini Gyration for Ndes Gyration for Nmax	6 4060	7 75 115	8 100 160	8 65 160
Air Voids, %Va (%Gmm Ndes)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)
% Gmm Nini	<= 91.5 ^[1]	<= 89.0 ^[1]	<= 89.0	___
% Gmm Nmax	<= 98.0	<= 98.0	<= 98.0	___
Dust to Binder Ratio ^[2] (% passing 0.075/Pbe)	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	1.2 - 2.0
Voids filled with Binder (VFB or VFA, %)	68 - 80 ^{[4] [5]}	65 - 75 ^{[3] [5]}	65 - 75 ^{[3] [5]}	70 - 80
Tensile Strength Ratio (TSR) (AASHTO T283) no antistripping additive with antistripping additive	0.750.80	0.75 0.80	0.75 0.80	0.75 0.80
Draindown (AASHTO T305) (%)	___	___	___	0.30

^[1] The percent maximum density at initial compaction is only a guideline.

^[2] For a gradation that passes below the boundaries of the caution zone (ref. AASHTO M323), the dust to binder ratio limits are 0.6 - 1.6.

^[3] For No. 5 (9.5mm) and No. 4 (12.5 mm) nominal maximum size mixtures, the specified VFB range is 70 - 76%.

^[4] For No. 2 (25.0mm) nominal maximum size mixes, the specified VFB lower limit is 67%.

^[5] For No. 1 (37.5mm) nominal maximum size mixes, the specified VFB lower limit is 67%.

2.05 ASPHALTIC SURFACE RELATED ITEMS

- A. If the plans call for Asphaltic Surface, Asphaltic Surface Detours, and Asphaltic Surface Patching bid items; submit a mix design that meets the requirements of the WisDOT. Furnish asphaltic mixture meeting the requirements specified for either type LT or MT mix under 460.2; except the Engineer will not require the Contractor to conform to the quality management program specified by the WisDOT.
- B. If the plans call for Asphaltic Surface Detours, Driveways and Field Entrances, Temporary, Safety Islands, Asphaltic Curb, Flumes, or Rumble Strips, the Contractor need not submit a mix design. Furnish aggregates mixed with a type AC asphaltic material. Use coarse and fine mineral aggregates uniformly coated and mixed with the asphaltic material in an Engineer-approved mixing plant. The Contractor may include reclaimed asphaltic pavement materials in the mixture.

PART 3 - EXECUTION

3.01 QUALITY MANAGEMENT PROGRAM (QMP)

- A. Provide and maintain a Quality Control (QC) program defined as all activities, including mix design, process control inspection, sampling and testing, and process adjustments related to producing and placing HMA pavement conforming to the specifications.
- B. The Owner or their designated representative may provide product Quality Verification (QV) as follows:
 - 1. By conducting verification testing of independent samples.
 - 2. By periodically observing Contractor sampling and testing.
 - 3. By monitoring required control charts exhibiting test results and control parameters.
 - 4. By the Engineer directing the Contractor to take additional samples at any time during production.
- C. Refer to [CMM 8-36](#) for detailed guidance on sampling, testing, and documentation under the QMP.

3.02 Contractor Testing

- A. Personnel Requirements
 - 1. Provide at least one full-time HMA technician qualified for sampling and production control testing at each plant site furnishing material to the project. Before mixture production begins, provide an organizational chart in the Contractor's laboratory. Include the names, telephone numbers, and current certifications of personnel with QC responsibilities. Keep the chart updated.
- B. Laboratory Requirements
 - 1. Conduct QC testing in a facility conforming to the department's laboratory qualification program.
 - 2. Ensure that testing equipment conforms to the equipment specifications applicable to the required testing methods.

3.03 Required Sampling and Testing of Asphalt Mixture

- A. Contracts with 5,000 Tons of Mixture or Greater
 - 1. Furnish and maintain a laboratory at the plant site fully equipped for performing Contractor QC testing. Have the laboratory on-site and operational before beginning mixture production.
 - 2. Obtain random samples and perform tests according to [CMM 8-36](#). Obtain HMA mixture samples from trucks at the plant. Perform tests the same day as taking the sample.
 - 3. Retain the split portion of the Contractor HMA mixture and blended aggregate samples for 14 calendar days at the laboratory site in a dry, protected area. The Engineer may decrease this 14-day retention period. At project completion, the Contractor may dispose of remaining samples if the Engineer approves. Use the test methods identified below, or other methods the Engineer approves, to perform the following tests at a frequency greater than or equal to that indicated:

- a. Blended aggregate gradations:
 - i. Drum plants:
 - 1. Field extraction by [CMM 8-36](#).
 - 2. Belt samples, optional for virgin mixtures, obtained from stopped belt or from the belt discharge using an Engineer-approved sampling device and performed according to AASHTO T11 and T27.
 - ii. Batch plants:
 - 1. Field extraction by [CMM 8-36](#).
 - b. Asphalt content (AC) in percent:
 - i. AC by calculation
 - ii. AC by nuclear gauge reading, optional.
 - iii. AC by inventory, optional.
 - c. Bulk specific gravity of the compacted mixture according to AASHTO T166.
 - d. Maximum specific gravity according to AASHTO T209.
 - e. Air voids (Va) by calculation according to AASHTO T269.
 - f. VMA by calculation according to AASHTO R35.
4. Test each design mixture at a frequency at or above the following:

Total Daily Plant Production for Department Contracts

<u>In Tons</u>	<u>Samples Per Day^[1]</u>
50 to 600	1
601 to 1500	2
1501 to 2700	3
2701 to 4200	4
greater than 4200	see footnote ^[2]

^[1] Frequencies are for planned production. If production is other than planned, conform to [CMM 8-36](#).

^[2] Add a random sample for each additional 1500 tons or fraction of 1500 tons.

- a. Also conduct field tensile strength ratio tests according to [ASTM D4867](#) on mixtures requiring an antistripping additive. Test each full 50,000 ton production increment, or fraction of an increment, after the first 5,000 tons of production. Perform required increment testing in the first week of production of that increment. If field tensile strength ratio values are either below the spec limit or less than the mixture design JMF percentage value by 20 or more, notify the Engineer. The Engineer and Contractor will jointly determine a corrective action.
- B. Contracts with Less Than 5,000 Tons of Mixture
- 1. Conform to the testing required for contracts with more than 5,000 tons of mixture except as modified as follows:
 - a. The Contractor may conduct QC tests in an off-site laboratory.
 - b. No field tensile strength ratio testing is required.

C. Contracts with Less Than 500 Tons of Mixture

1. The Engineer may waive QC testing on contracts with less than 500 tons of mixture. If testing is waived, acceptance will be by visual inspection unless defined otherwise by contract change order.
2. If HMA density testing is waived, QC testing is also waived.

D. Temporary Pavements

1. The Engineer may waive all testing for temporary pavements, defined for this purpose as pavements that will be placed and removed before contract completion.

E. Documentation

1. Maintain records, control limits, job mix formula adjustment, and corrective actions per the WisDOT Standard Specifications.

3.04 Owner Provided Testing

- A. The Engineer may conduct QV tests to determine the quality of the final product and measure characteristics that predict relative performance.

B. Owner Verification Testing

1. Qualified personnel will obtain random samples, as requested by the Engineer, sampling from trucks at the plant. Sample size will be adequate to run the appropriate required tests, in addition to one set of duplicate tests that may be required for dispute resolution. The Engineer will split the sample for testing and retain the remaining portion for additional testing if needed. The verification testing will verify product quality using the test methods specified by the WisDOT Standard Specifications, or other Engineer-approved methods.
2. The anticipated schedule for the randomly selected test for each design mixture will be completed at the following minimum frequency:

For Tonnages Totaling:

Less than 501 tons:	no tests anticipated
From 501 to 5,000 ton:	one test
More than 5,000 tons:	add one test for each additional 5,000-ton increment

C. Acceptable Verification Parameters

1. The Engineer will provide test results to the Contractor within 2 mixture-production days after obtaining the sample. The quality of the product is acceptably verified if it meets the following limits:
 - a. V_a is within a range of 2.7 to 5.3 percent.
 - b. VMA is within minus 0.5 of the minimum requirement for the mix design nominal maximum aggregate size.

2. If QV test results are outside the specified limits, the Engineer will discuss with the Contractor the remedy offered by the Contractor. Potential corrective action may include as follows:
 - a. Remove and replace unacceptable material at no additional expense to the Owner.
 - b. The Owner will reduce pay for the tonnage of nonconforming mixture, if the Engineer recommends the mixture be allowed to remain in place. Reduction will be based on terms defined in Section 460.5 of the WisDOT Standard Specifications.

3.05 Asphalt Plants

- A. Produce asphalt in plants in accordance with Section 450.3 of the WisDOT Standard Specifications. Provide delivery tickets indicating gross, tare, and net weights as well as date, time, ticket number, project, and mix type for all loads of asphalt pavement delivered to the project.

3.06 Construction

- A. Construct HMA pavement of the type the bid item indicates encoded as follows:

Combined Bid Item Encoding

Gradation		Traffic	Binder	Designation	
GRADATIONS (NMAS)		TRAFFIC VOLUME		BINDER DESIGNATION LEVEL	
1	37.5 mm	LT	Low	S	Standard
2	25.0 mm	MT	Medium	H	Heavy
3	19.0 mm	HT	Heavy	V	Very Heavy
4	12.5 mm			E	Extremely Heavy
5	9.5 mm				
6	4.75 mm				

- B. Construct HMA pavement conforming to the general provisions of [450.3](#).

3.07 Thickness

- A. Provide the plan thickness for lower and upper layers limited as follows:

Nominal Size	Minimum Layer Thickness in inches	Maximum Lower Layer Thickness in inches	Maximum Upper Layer Thickness in inches	Maximum Single Layer Thickness ^[3] in inches
No. 1 (37.5 mm)	4.5	6	4.5	6
No. 2 (25.0 mm)	3	5	4	6
No. 3 (19.0 mm)	2.25	4	3	5
No. 4 (12.5 mm) ^{[1] [4]}	1.75	3 ^[2]	2.5	4
No. 5 (9.5 mm) ^{[1] [4]}	1.5	3 ^[2]	2	3

^[1] SMA mixtures use nominal size No. 4 (12.5 mm) or No. 5 (9.5 mm).

^[2] SMA mixtures with nominal sizes of No. 4 (12.5 mm) and No. 5 (9.5 mm) have no maximum lower layer thickness specified.

^[3] For use on cross-overs and shoulders.

^[4] Can be used for a leveling layer or scratch coat at a reduced thickness.

3.08 HMA Pavement Density Maximum Density Method

- A. Compact all layers of HMA mixture to the density table 460-3 shows for the applicable mixture, location, and layer.

TABLE 460-3 MINIMUM REQUIRED DENSITY^[1]

Location	Layer	Percent of Target Maximum Density		
		Mixture Type		
		LT and MT	HT	SMA ^[5]
Traffic Lanes ^[2]	Lower Upper	91.5 ^[3]	92.0 ^[4] 92.0	—
		91.5		—
Side Roads, Crossovers, Turn Lanes, & Ramps	Lower	91.5 ^[3]	92.0 ^[4]	—
	Upper	91.5	92.0	—
Shoulders & Appurtenances	Lower Upper	89.5	89.5	—
		90.5	90.5	—

^[1] The table values are for average lot density. If any individual density test result falls more than 3.0 percent below the minimum required target maximum density, the Engineer may investigate the acceptability of that material.

^[2] Includes parking lanes as determined by the Engineer.

^[3] Minimum reduced by 2.0 percent for a lower layer constructed directly on crushed aggregate or recycled base courses.

^[4] Minimum reduced by 1.0 percent for a lower layer constructed directly on crushed aggregate or recycled base courses.

^[5] The minimum required densities for SMA mixtures are determined according to [CMM 8-15](#).

3.09 Pavement Density Determination

- A. The Engineer will determine the target maximum density using procedures described in [CMM 8-15](#). The Engineer will determine density as soon as practicable after compaction and before placement of subsequent layers or before opening to traffic.
- B. Do not re-roll compacted mixtures with deficient density test results. Do not operate continuously below the specified minimum density. Stop production, identify the source of the problem, and make corrections to produce work meeting the specification requirements.
- C. A lot is defined in [CMM 8-15](#) and placed within a single layer for each location and target maximum density category indicated in [table 460-3](#). The lot density is the average of all samples taken for that lot. The Engineer determines the number of tests per lot according to either the linear subplot system or the nominal tonnage system defined in [CMM 8-15](#).

3.10 Waiving Density Testing

- A. The Engineer may waive density testing for one or more of the following reasons:
 1. It is impracticable to determine density by the lot system.
 2. The contract contains less than 750 tons of a given mixture type placed within the same layer and target maximum density category.

- B. If the department waives density testing notify the Contractor before paving, the department will accept the mixture by the ordinary compaction procedure.
- C. If HMA QC testing is waived, density testing is also waived.

3.11 Ordinary Compaction

- A. If density testing is waived by Engineer, compact using the ordinary compaction procedure. After spreading and strike-off and while still hot, compact each layer thoroughly and uniformly by rolling. Compact patching, leveling, and wedging layers of asphaltic pavement or surfacing; all layers of plant mixed asphaltic base and base widening; driveways; and other non-traffic areas until no further appreciable consolidation is visible under the action of the compaction equipment. Use 2 or more rollers per paver if placing more than approximately 165 tons of mixture per hour.
- B. Roll during daylight hours unless providing artificial light the Engineer finds satisfactory. Use the appropriate number of rollers to achieve the specified compaction, surface finish, and smoothness requirements. Ensure that the compacted surface is smooth and true to the established crown and grade.
- C. Roll the entire surface until achieving the specified compaction and, to the extent practicable, eliminate roller marks. If turning or reversing the roller, or other operations, causes any scuffing or displacement immediately correct the damage and revise the rolling procedure to prevent further damage. Keep roller wheels moistened to keep mixture from sticking to them. Do not use excess water. Do not disturb the line and grade elevation of edges of the asphaltic pavement or surfacing.
- D. Along forms, curbs, headers, walls, and at other places not accessible to the roller, compact the mixture thoroughly with hot hand tampers or mechanical tampers giving equivalent compression. On depressed areas use a trench roller or other Engineer-approved equipment.
- E. Remove and replace material that is loose and broken, mixed with dirt, or is otherwise unacceptable with fresh hot mixture. Also remove and replace areas with excess asphaltic material. Compact replaced mixture immediately flush with the adjacent placement.
- F. The Engineer will assess the compacted density using the methods specified for the particular type of work.

3.12 Asphaltic Mixture Hauling Vehicles

- A. Provide trucks for hauling asphaltic mixtures with tight, clean, and smooth boxes. The Contractor may thinly coat boxes with a release agent chosen from the department's approved products list. Drain excess release agent after coating. Equip each box with a cover big enough to protect the mixture. Do not use trucks that show oil leaks of any magnitude.

3.13 Transfer Devices

- A. Ensure that transfer devices have surge bin capacity adequate to pave continuously at a uniform speed. If maintaining uniform and continuous paving, the Engineer may allow the Contractor to omit the surge bin. Do not use devices that cause vibrations or other motion that adversely affect the finished surface.

3.14 Pavers

- A. Ensure that the screed or strike-off assembly produces a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. Use a screed adjustable for the required crown and cross-section of the finished pavement.
- B. Ensure that pavers are equipped with an activated screed or strike-off assembly and use activation at all times during paving unless the Engineer allows otherwise. Do not extend the screed with one or more static extensions totaling more than 12 inches at either screed end, except at the shoulder end for paving shoulders.
- C. Provide pavers with automatics that control the elevation and slope of the screed. Automatic controls are not required when paving entrances, approaches, side road connections, small irregular areas, or if the Engineer determines using automatic controls is impracticable. Use both grade and slope controls whenever automatics are required; except when the Engineer waives the longitudinal or grade control requirement for the final surface. Ensure that the operator can adjust or vary the slope throughout super elevated curves and transitions. Also ensure that the system allows the sensor to operate on either side of the paver.
- D. If automatics break down, the Contractor may pave under manual control only until the end of that working day.

3.15 Compaction Equipment

- A. Ensure rollers are in good mechanical condition, capable of operating both forwards and backwards, and the operating mechanism allows for starting, stopping, or reversing direction in a smooth manner, without loosening or distorting the surface being rolled.
- B. Equip rollers with a drum or tire lubricator. Do not lubricate with petroleum or tar products.

3.16 Constructing Asphaltic Mixtures

- A. Do not place asphaltic mixture when the air temperature approximately 3 feet above grade, in shade, and away from artificial heat sources is less than 36°F for upper layers or 32°F for lower layers unless the Engineer allows in writing. The Contractor should place HMA pavement for projects in the northern asphalt zone between May 1 and October 15 inclusive and for projects in the southern asphalt zone between April 15 and November 1 inclusive. The northern zone is all the portion of the state north of the following counties: La Crosse, Monroe, Marathon, Shawano, Brown, and Door. If paving is performed during the months of October, November, December, March, April, or May, prepare cold weather paving plan as required herein.
- B. Place asphaltic mixture only on a prepared, firm, and compacted base, foundation layer, or existing pavement substantially surface-dry and free of loose and foreign material. Do not place over frozen subgrade or base, or where the roadbed is unstable.

3.17 Cold Weather Paving

- A. Conform to these cold weather paving provisions for work performed for HMA Pavement or Asphaltic Surfaces.

- B. Submit a written cold weather paving plan to the Engineer at the preconstruction meeting. In that plan outline material, operational, and equipment changes for paving when the air temperature approximately 3 feet above grade, in shade, and away from artificial heat sources is less than 40°F. Include the following:
1. Use a WisDOT accepted HMA mix design that incorporates a warm mix additive from the WisDOT approved products list. Do not use a foaming process that introduces water into the mix.
 2. Identify the warm mix additive and dosage rate.
 3. Identify modifications to the compaction process and when to use them.
- C. Engineer will review the plan, however, Engineer acceptance of the plan does not relieve the Contractor of responsibility for the quality of HMA pavement placed in cold weather.
- D. Do not place asphaltic mixture when the air temperature approximately 3 feet above grade, in shade, and away from artificial heat sources is less than 40°F unless a valid Engineer-accepted cold weather paving plan is in effect.
- E. If the national weather service forecast for the construction area predicts ambient air temperature less than 40°F at the projected time of paving within the next 24 hours, confirm or submit revisions to the cold weather paving plan for Engineer validation. Update the plan as required to accommodate the conditions anticipated for the next day's operations. Upon validation of the plan, the Engineer will allow paving for the next day. Once in effect, pave conforming to the Engineer-accepted cold weather paving plan for the balance of that work day or shift regardless of the temperature at the time of paving.
- F. Do not place asphaltic mixture during the calendar period between October 15 and the following May 1, except with written approval or order of the Engineer. In the event of such approval or order, the conditions and restrictions of placement set forth in the preceding paragraphs apply. If the Engineer does not approve placement of asphaltic mixture between October 15 and the following May 1, the Contract time for the completion of the work is not extended automatically extended.
- G. When placing of asphaltic mixtures is continued after October 15 with the Engineer's approval or order, either at the request of the Contractor or in order to complete the work to the stage required by the Contract, the asphaltic paving work will be considered to have been done at the Contractor's risk and final inspection of the asphaltic paving work will be deferred until May of the following year. Prior to final acceptance of pavement so placed, repair, restore or replace, at the Contractor's own cost and expense and in a manner approved by the Engineer, all damage or defects in the asphaltic pavement, which in the judgment of the Engineer, are attributable to temperature and weather conditions which prevailed after October 15.
- H. When placing of asphaltic mixtures is continued after October 15 by order of the Engineer for the convenience of the Owner, the final inspection and acceptance will be accomplished upon completion of such placement.

3.18 Preparing and Storing Mixtures

- A. Heat and combine aggregate and asphaltic material to produce a mixture within the temperature range the mixture design specifies when discharged from the mixer. Mix until achieving a homogeneous mixture with uniformly coated aggregate. The Contractor may store the mixture in silos.

3.19 Transporting and Delivering Mixtures

- A. Deliver the mixture to the paver receiving hopper at a temperature within 20°F of the temperature the asphaltic material supplier recommends. Cover loads during inclement weather or when the ambient air temperature falls below 65°F.
- B. If depositing asphaltic mixture on the roadway, provide equipment to pick up substantially all of the asphaltic mixture from the roadway and load it directly into the paver receiving hopper. Use either a device integral to the paver or intermediate transfer equipment.

3.20 Correcting Base

- A. Before placing asphaltic base or surface courses, correct the existing pavement by filling potholes, sags, and depressions; altering the existing crown; or other corrections the Engineer requires. Place asphaltic lower layer mixtures where and as the Engineer directs. The Contractor may hand place or use blade graders or mechanical spreaders to place mixture used for wedging, leveling layers, or filling holes. Feather the mixture out to become co-planar with adjoining areas and, unless the Engineer directs otherwise, compact uniformly.

3.21 Spreading and Finishing Mixture

- A. Place asphaltic mixtures in layers to the typical sections the plans show with self-propelled pavers. Pave at a constant speed appropriate for the paver and mixture that ensures uniform spreading and strike-off with a smooth, dense texture and no tearing or segregation. Do not pave faster than the average delivery rate of asphaltic mixture to ensure, as nearly as possible, continuous paving.
- B. If placing the initial lane of a given layer, use a sensor off a tight string line, a mobile string line, or a traveling straightedge whichever the Engineer approves for the specific field conditions. On subsequent lanes of the layer, the Contractor may use a sensor off the adjacent lane surface.
- C. Avoid raking over machine spread and finished material on surface courses to the extent possible to prevent segregation.
- D. The Contractor may spread material by hand in areas not accessible to pavers. Dump material outside the placement area, spread into place with shovels, and shape to the required grade and contour with rakes and lutes. Do not rake material from a pile of dumped material.
- E. Do not haul over any portion of a placed layer until after the final rolling is complete on that portion.
- F. If a longitudinal joint other than the notched wedge joint is constructed, place multi-lane pavement so that each day's placement in all lanes ends at the same station, unless the Engineer directs or allows otherwise.

3.22 Applying Tack Coat

- A. Apply tack coat as specified in [455.3](#) to each layer of a plant-mixed asphaltic base or pavement that will be overlaid with asphaltic mixture under the same contract.

3.23 Jointing

- A. Place all layers as continuously as possible without joints. Do not roll over an unprotected end of freshly laid mixture unless interrupting placement long enough for the mixture to cool. If interrupting placement, ensure proper bond with the new surface. Form joints by cutting back on the previous run to expose the full depth of the layer. After resuming placement, place the fresh mixture against the joint to form intimate contact and be co-planar with the previously completed work after consolidation.
- B. Where placing against existing HMA pavement, cut back the existing mat to form a full-depth butt joint.
- C. Construct notched wedge longitudinal joints for mainline paving if the pavement thickness conforms to the minimums specified in 460.3, unless the Engineer directs or allows an alternate joint. Taper each layer at a slope no greater than 12:1. Extend the taper beyond the normal lane width, or as the Engineer directs. Ensure that tapers for all layers directly overlap and slope in the same direction.
- D. Place a 1/2- to 1-inch vertical notch after compaction at the top of tapers on all layers. Place the finished longitudinal joint line of the upper layer at the pavement centerline for 2-lane roadways, or at the lane lines if the roadway has more than 2 lanes.
- E. Construct the tapered portion of each layer using an Engineer-approved strike-off device that will provide a uniform slope and will not restrict the main screed. Apply a weighted steel side roller wheel, as wide as the taper, to the tapered section. Compact the initial taper section to as near the final density as possible. Apply a tack coat to the taper surface before placing the adjacent lane.
- F. Clean longitudinal and transverse joints coated with dust and, if necessary, paint with hot asphaltic material, a cutback, or emulsified asphalt to ensure a tightly bonded, sealed joint.

3.24 Surface Requirements

- A. Test the surface at Engineer-selected locations with a 10-foot straightedge or other Engineer-specified device. Ensure that upper layers show no variation greater than 1/8 inch between any 2 surface contacts. Ensure that lower layers, shoulder surfacing, and surfacing on temporary connections and bypasses show no variation greater than 1/4 inch between any 2 surface contacts.
- B. Remove and replace or otherwise correct, using Engineer-approved methods, humps or depressions exceeding the specified tolerance.

3.25 Paving Shoulders

- A. Conform to the other general paving requirements except if constructing shoulders separately and the placement width is too narrow to accommodate the required pavers and rollers, the Contractor may use Engineer-approved alternate spreading and compaction equipment. Alternate equipment must be capable of satisfactorily laying mixture to the required width, thickness, texture, and smoothness.

3.26 Safety EdgeSM

- A. If indicated on the typical section, construct safety edge monolithically with and extending beyond the edge of pavements that have no paved shoulder, have paved shoulders 3 feet wide or less, and at other locations the plans show. Safety edge is not required on edges that abut other HMA or concrete elements or where the Engineer excludes for constructability issues.

- B. Ensure that after final rolling the safety edge angle is within the tolerances the plans show. The Contractor may use full depth sawing to remove formed edges integrally placed with pavement where safety edge is not required.
- C. Use a paver equipped with a wedge maker from the department's approved products list capable of constructing the specified edge cross-section. Do not use a single plate strike off.
- D. Place the finished shoulder material to the top of the safety edge.

3.27 Maintaining the Work

- A. Protect and repair the prepared foundation, tack coat, base, paved traffic lanes, shoulders, and seal coat. Correct rich or bleeding areas, breaks, raveled spots, or other nonconforming areas in the paved surface.
- B. Unless the contract specifies otherwise, conform to the following:
 - 1. Keep the road open to all traffic during construction.
 - 2. Prepare the existing foundation for treatment.
 - 3. Incorporate loose roadbed aggregate as a part of preparing the foundation, in shoulder construction, or dispose of as the Engineer approves.

3.28 Tack Coat

- A. Apply tack coat only when the air temperature is 32°F or more unless the Engineer approves otherwise in writing. Before applying tack coat, ensure that the surface is dry and reasonably free of loose dirt, dust, or other foreign matter. Do not apply if weather or surface conditions are unfavorable or before impending rains.
- B. Use tack material of the type and grade the contract specifies. The Contractor may, with the Engineer's approval, dilute tack material. Provide calculations using the asphalt content as received from the supplier and subsequent Contractor dilutions to show that as-placed material has 50 percent or more residual asphalt content. Apply at 0.050 to 0.070 gallons per square yard, after dilution, unless the contract designates otherwise. The Engineer may adjust the application rate based on surface conditions. Limit application each day to the area the Contractor expects to pave during that day.
- C. Unless the contract specifies otherwise, keep the road open to all traffic during the work. Plan and prosecute tacking operations to adequately provide for traffic without damaging the work.
- D. Have all necessary equipment available on the job before beginning tack coat operations.
- E. Heat the tack material by circulating steam through the coils of the tank or use another Engineer-approved system. Use equipment designed to heat without burning or overheating any portion of the material. Provide effective and positive control of the heat at all times.
- F. The department will reject tack material from tank cars without heating coils, or with defective heating coils, unless the Contractor uses Engineer-approved alternate methods to heat the material without introducing moisture. Do not agitate or heat the tack coat material by directly introducing live steam.
- G. Provide a tachometer, pressure gauges, and accurate volume measuring devices or a calibrated tank. Also provide a thermometer for measuring the temperature of the tank contents.

- H. Equip distributors with a pump power unit and full circulation spray bars adjustable laterally and vertically. Provide a heating system that circulates material through the spray bar during the entire heating process. Also provide a hose and spray nozzle to apply tack to areas inaccessible to the spray bar.
- I. Prepare the base or existing surface and immediately before applying tack material, sweep existing surfaces to remove dust, dirt, or other objectionable material.
- J. Do not incorporate overheated or otherwise damaged tack material.
- K. Place tack in a single application unless the contract or Engineer specifies otherwise. Determine the appropriate width for the application based on traffic handling and sequencing of subsequent surface course construction. Distribute uniformly over the surface to be treated.
- L. Determine an application rate for the surface condition required to effectively bond the overlying material.
- M. Correct under application by applying additional material. If the Contractor cannot maintain the application rate within tolerances, discontinue operations and make the necessary corrections to personnel or equipment required to remedy the problem.
- N. Turn outside edges nozzle to spray parallel to the road centerline. Do not operate with any clogged nozzles.
- O. Protect structures, as the Engineer approves, to prevent spatter or marring by tacking operations. Include surfaces of railings, curbs, gutters, and other appurtenances of existing structures. Also protect adjacent concrete pavement that will not be resurfaced with asphaltic pavement or surfacing.
- P. Protect and repair the existing surface and the tack coat. Correct areas with excess or deficient tack material and any breaks, raveled spots, or other areas where bond might be affected.

3.29 Asphaltic Surface

- A. Under the Asphaltic Surface, Asphaltic Surface Detours, and Asphaltic Surface Temporary items; straightedge the surface. Provide a finished surface with no variation greater than 1/4 inch in 10 feet. Remove and replace out-of-tolerance material or correct the surface using Engineer-approved methods.

3.30 Asphaltic Curb

- A. Construct asphaltic curb in one layer on a prepared asphaltic pavement or base foundation. Clean the pavement surface area the curb will occupy to ensure a good bond. Apply a tack coat to the area as the Engineer directs.
- B. The Contractor may place the curb by one of the following methods:
 1. With an Engineer-approved curb laying machine that places and compacts the mixture and finishes the curb to the required shape, grade, and dimensions.
 2. In forms fabricated to the curb shape. Place and thoroughly compact the mixture with vibratory compactors or mechanical tampers and screed to a smooth finish.
 3. For small quantities, by hand placing and shaping. Form the back of the curb. Place, tamp, and shape with hand tools. Provide a smooth-finished surface on the curb face and top.

3.31 Rumble Strips

- A. Construct asphaltic rumble strips by milling the asphaltic surface. Use a rotary head milling machine with a cutting tip pattern that will produce a relatively smooth cut of the size, shape, spacing, and smoothness the plans show. Use cutting heads on a suspension independent from the power unit to allow the heads to self-align with slopes and irregularities. The machine will have a guidance system that consistently provides the plan alignment of the rumble strips.
- B. Before beginning the work, demonstrate to the Engineer that the operation achieves the desired surface inside each depression without tearing or snagging the asphaltic pavement or surfacing. Place rumble strips in the pattern and shape the plans show. For shoulders carrying temporary traffic during construction, do not install rumble strips until after routing traffic back to the mainline.
- C. At the end of each work day, move equipment and material out of the clear zone and sweep or vacuum the traveled way pavement and shoulder areas. Sweep away or vacuum up milling debris before opening adjacent lanes to traffic. Dispose of waste material as specified in 203.3.4; do not place on the finished shoulder surface.

3.32 Measurement

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.
- B. Measure Asphaltic Surface items by the ton acceptable delivered to the project and placed.
- C. Measure Asphaltic Curb by the linear foot acceptably completed, measured along the base of the curb face.
- D. Measure Asphaltic Flumes and Asphaltic Intersection Rumble Strips by the square yard acceptably completed.
- E. Measure the Asphaltic Shoulder Rumble Strips bid items and Asphaltic Centerline Rumble Strips 2-Lane Rural by the linear foot acceptably completed, measured as the length along each side of the traveled way, from the center of the first groove in a segment to the center of the last groove in that segment. A segment is a series of grooves including 50-foot and shorter gaps as well as skips shown in the plans. Gaps greater than 50 feet define a new segment. The department will deduct for skips greater than shown in the plans.
- F. Measure Tack Coat by either gallon (GAL) or TON for material acceptably delivered and placed on the project. Contractor to provide tickets for the material used on the project. Volume measured for payment will not include quantities that exceed the application rated described herein.
- G. Measure HMA Pavement by the TON for mixture acceptably produced, delivered, and placed on the project. No measurement will be made for excessive thickness placed by the Contractor. If excessive thickness is placed, Engineer will calculate the reduction to quantities authorized for payment.

3.33 BASIS OF PAYMENT

- A. The department will pay for measured quantities at the contract unit price under the following bid items:

<u>DESCRIPTION</u>	<u>UNIT</u>
Asphaltic Surface	TON
Asphaltic Surface Patching	TON
Asphaltic Surface Detours	TON
Asphaltic Surface Driveways and Field Entrances	TON
Asphaltic Surface Temporary	TON
Asphaltic Surface Safety Islands	TON
Asphaltic Curb	LF
Asphaltic Flumes	SY
Asphaltic Shoulder Rumble Strips	LF
Asphaltic Shoulder Rumble Strips 2-Lane Rural	LF
Asphaltic Intersection Rumble Strips	SY
Asphaltic Centerline Rumble Strips 2-Lane Rural	LF
Tack Coat	TON
Tack Coat	GAL
HMA Pavement (gradation) LT (binder)(designation)	TON
HMA Pavement (gradation) MT (binder)(designation)	TON
HMA Pavement (gradation) HT (binder)(designation)	TON
HMA Pavement (gradation) SMA (binder)(designation)	TON

- B. Payment for the Asphaltic Surface items is full compensation for submitting an asphaltic mixture design; for preparing the foundation; for providing the asphaltic mixture, including asphaltic material and reclaimed asphaltic pavement materials; and for compacting the mixture.
- C. Payment for Asphaltic Surface Temporary is also full compensation for maintenance during the time the contract specifies.
- D. Payment for Asphaltic Curb is full compensation for providing the asphaltic mixture, including asphaltic material and reclaimed asphaltic pavement materials; for compacting the mixture; and for forming the curb.
- E. Payment for Asphaltic Flumes is full compensation for preparing the foundation; for providing the asphaltic mixture, including asphaltic material and reclaimed asphaltic pavement materials; and for compacting the mixture.
- F. Payment for the Asphaltic Shoulder Rumble Strips bid items, Asphaltic Centerline Rumble Strips 2-Lane Rural, and Asphaltic Intersection Rumble Strips is full compensation for milling; for sweeping or vacuuming; and for disposing of waste materials.
- G. Payment for Tack Coat is full compensation for providing tack coat; for preparing the surface; and for maintaining the completed work
- H. Payment for the HMA Pavement bid items is full compensation for providing HMA pavement including binder; for mixture design; for preparing the foundation; and testing. If sawing pavement pay items are not included in the agreement, all work associated with sawing pavements are incidental to HMA pavement.

END OF SECTION 32 12 16

SECTION 32 16 00 CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS

PART 1 - GENERAL

1.01 SUMMARY

- A. This work consists of constructing concrete curb, gutter, curb and gutter, sidewalks, steps, landings and driveways with or without reinforcement, of the dimensions and design as indicated, placed in one course on the prepared foundation or base, at the locations and to the required lines and grades, all as shown on the Plans and provided by the Contract.

1.02 SUBMITTALS

- A. Prior to mixing of concrete, submit to the Engineer for review a proposed concrete mix design for all the various types of concrete specified and/or scheduled.
- B. Include proportions, materials, manufacturer's name, and catalog number for items such as Portland cement, admixtures, and name of ready-mix supplier.
- C. Ready-mix delivery tickets:
 - 1. Maintain a record at the job site showing date, time, and place of each pour of concrete together with ready-mix delivery tickets certifying contents of the pour.
 - 2. Make the record available to the Engineer for inspection upon request. Upon completion of the work, deliver the record and the delivery tickets to the Engineer.

1.03 QUALITY ASSURANCE

- A. Any material or operation specified by reference standards (i.e., Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction, current edition), industry standards, commercial standards, other government standards, or other published standards will comply with the requirements of the standards listed. Where the project specifications are more stringent than the references standard, the project specifications will govern.
- B. Ready-Mixed Concrete: All ready-mixed concrete will be furnished by an approved supplier whose plant is approved by the Wisconsin Department of Transportation.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Furnish materials conforming to the State of Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction, current edition (WisDOT Spec).
- B. Provide Grade concrete conforming to Section 501 of WisDOT Specification.
- C. All concrete will be air entrained to percentages listed in Section 501.

- D. Concrete slump will be in accordance with Section 501.
- E. Concrete for sidewalk, curb and gutter, driveway, and aprons will have a 28-day compressive strength of 4000 psi. If necessary adjust WisDOT section 501 proportions to achieve required 28-day strength.
- F. Concrete placed after October 15th will not contain fly ash. The engineer may also suspend the use of fly ash before that date if extended cold periods are expected, such that proper curing of the concrete would be unobtainable.

2.02 NON-CONFORMING CONCRETE

- A. If non-conforming material is allowed to remain as constructed, the Engineer will determine the quantity of non-conforming material. If the project is not constructed on the basis of a unit cost payment for work (e.g. lump sum project) the reductions listed herein will be applied to the material costs multiplied by a factor of 2.0. Only one price adjustment will be applied to a given quantity of material. If the quantity in question is subject to more than one of the following conditions, apply the adjustment with the greater price reduction.

Slump

0.25 inches out of specification.....	2% price reduction
0.50 to 0.75 inches out of specification.....	5% price reduction
1.00 to 1.75 inches out of specification.....	25 % price reduction
2 inches or more out of specification.....	Remove & replace or 50% price reduction

- B. Apply price reductions to results of slump tests only. If the Engineer elects to take a slump test for slip form pavement, do not take a price reduction if both of the following are met:
 - 1. Result of slump test is less than 4 inches.
 - 2. Pavement meets edge slump spec as defined in WisDOT Standard Specifications.

Air Content

0.5 % or more above specification	10% price reduction
0.1 % to 0.4% above specification	5% price reduction
0.1 % to 0.5% below specification	20% price reduction
0.6 % to 1.0% below specification	30% price reduction
More than 1.0% below specification.....	Remove and replace or 50% price reduction

Time Limit

Use of concrete after time limit exceeded	25% price reduction
---	---------------------

C. Gradation

- 1. If air, slump, and strength (if applicable) meet specifications, but aggregates are non-conforming, apply one of the two following price reductions:
 - a. 10% price reduction on the cubic yard cost of the aggregate material invoice price
 - b. 5% price reduction on the bid item unit price, if the aggregate invoice price is not available

PART 3 - EXECUTION

3.01 GENERAL

A. Preparation of Foundation

1. Prepare foundation by excavating or filling to the lines, grades and cross section shown on the Plans and required for placing the concrete and/or subbase as shown on the Plans. Remove and replace with suitable material soft or unsuitable material underlying the proposed curb, gutter, sidewalk, or paved areas. Compact all foundation materials thoroughly and finish to a firm, true surface. In cuts, construct foundation sufficiently wide to permit placing of forms and performing the required work of placing the concrete and finishing. On embankments, construct the foundation at least 2 feet wider than the proposed sidewalk and extending not less than 1-foot beyond each edge of the concrete. Fill all holes, ruts and other depressions in the foundation with materials similar to those existing in the foundation, or the Contractor may elect to use granular subbase or dense aggregate base course in which case there will be no additional compensation for such item. Thoroughly moisten the foundation immediately prior to placing the concrete.
2. When indicated on the Plans, place granular subbase or base course under the concrete masonry at the locations, thickness and section shown on the Plans.
3. Concrete will not be placed on frozen base or subgrade.
4. Cease concreting operations when there is insufficient natural light, unless an adequate and approved artificial lighting system is provided and operated.
5. Forms will be of wood or metal and will be straight and have sufficient strength to resist springing, tipping or other displacement during the process of depositing and consolidating the concrete. The forms will be of the full depth of the required concrete sections and will be designed to permit secure fastening. Construct and shape face boards, if used, that their lower edge conforms to the lines and radius indicated by the cross section for the pertinent structure as shown on the Plans. Use flexible or curved forms of proper radius for curves of 100 ft. radius or less. Clean thoroughly all forms and oil surfaces prior to concrete placement.
6. Deliver ready-mixed concrete to the site of the work and completely discharge from the transporting vehicle, other than non-agitating types, within the following time limits or batch lives commencing with the introduction of the mixing water to the cement or the cement to the aggregates:

When the atmospheric temperature at time of placement is less than 60° F 1½ hours

When the atmospheric temperature at time of placement is 60° F or higher..... 1 hour

Should the Contractor elect to add an approved retarder to the concrete mixture when the atmospheric temperature is 60° F or higher, the time limit may be extended to 1½ hours

7. These times may be reduced by the Engineer or inspector under conditions contributing to quick stiffening of the mix, or during cold weather when loss of heat occurs to such an extent that the concrete will not be at the proper temperature when placed.

8. Except during the mixing revolutions, the drum or agitator of the vehicle will operate at agitating speed until discharge of the mix.

B. Mixers and Mixing

1. When concrete is mixed in a truck mixer, each batch will be mixed not less than 70 or more than 110 revolutions of the drum or blades at the rate of rotation designated by the mixer manufacturer as mixing speed. Additional revolutions, if any, will be at the speed designated by the manufacturer as the agitating speed. All materials, including mixing water, will be in the mixer drum before mixing revolutions are started.
2. Add mixing water at the batching plant; if additional mixing water is required to obtain the specified slump, water may be added with the permission of the Engineer. The total of all free and added water will not be in excess of that permitted elsewhere in section 501 of the WisDOT Specifications. If additional water is added at the site of the work, a minimum of 20 revolutions is required of the truck mixer at mixing speed before discharge of any concrete. Complete additional adding water and mixing at the site of the work within 45 minutes after the original introduction of the mixing water to the cement or the cement to the aggregates. This time may be extended by the Engineer to 75 minutes for those grades of concrete for which the delivery time limit is 1½ hours. When additional revolutions at mixing speed are required because of water added at the site, the total revolutions at mixing speed will not exceed 110.
3. Equip truck mixers with an approved revolution counter and, unless also equipped with an accurate and dependable device or counter which will indicate and control the number of revolutions at mixing speed, complete mixing at the job site or at the batching plant and operate the mixing unit at agitating speed between the plant and job site.

C. Material Testing

1. Quality control testing is the responsibility of the contractor to complete. Complete testing by personnel experienced in the WisDOT procedures for testing concrete and aggregates. Quality control testing includes test specimens cast to determine strength for form removal, construction traffic loading, and opening to traffic. Quality control testing is required to assure the Owner that the work completed is meeting the requirements of the specifications. Provide a copy of all test results to Engineer.
2. Perform random QC testing at the following frequencies:
 - a. Test air content and slump at the start of each day's operation within the first two loads of placement.
 - b. In addition to the startup test, perform additional test for air content and slump and cast one set of 3 cylinders a minimum of once per 100 cubic yards for each mix grade and placement.
 - c. Slump tests are waived on slip formed placement.
3. Complete entrained air tests made at the site in accordance with ASTM C231. This includes using properly calibrated pressure-type air meter. Tests for air entrainment for concrete placed by pumping at the point of discharge from the pump line.
4. Submit tests results to the Engineer.

5. Each set of test cylinders will consist of 3 cylinders. The cylinders will be kept in a 60 to 80 degrees Fahrenheit temperature range and protected from moisture loss at the job for a period of 24 to 48 hours. They will be carefully delivered to the lab, lab cured and tested 28 days. Two cylinders will be broken at 28 days and the compressive strength for acceptance will be the average of the two breaks. The third will only be tested if there is significant deviation in the two 28-day tests, and at least one test fails.
6. Additional cylinders may be cast by the Contractor as deemed appropriate for determining when local traffic may use or cross the new concrete surface without harming it.
7. Engineer, or representative designated by Owner, will complete quality verification testing. The rate of verification testing will be determined by the Engineer, but will generally follow the following frequencies:
 - a. One slump test, air content, and set of 3 test cylinders cast a minimum once per day and one per every 200 cubic yards of concrete placed per day.
 - b. Ancillary placement quantities of less than 15 CY may be exempt from the verification testing and casting of test specimens at the discretion of the Engineer. Provide documentation verifying that an approved WisDOT mix design was used for all ancillary placements.

D. Cold Weather Pours

1. Placement of concrete will occur only when outside air temperatures at the time of placement is at least 40°F and rising. If temperatures within the resulting 48 to 72 hours after placement are expected to drop below 40°F, install protective covering as defined below. If either of these temperature conditions are applicable, concrete mixture will be placed at a minimum temperature of 55°F and covered as quickly as possible after finishing operations have been completed. If necessary to maintain placement temperature, aggregates and/or mix water may be heated according to WisDOT 415. The cement will not be heated, nor will salt or chemical admixtures be added to the concrete mix to prevent freezing.

3.02 CURING AND PROTECTION OF CONCRETE

- A. Construct suitable and substantial temporary crossings to bridge over the concrete necessary to provide for traffic across the curb and gutter or sidewalk at all locations designated on the Plans or in the Contract or to provide access to adjacent parcels if required in the specifications. Structures will be of sufficient length to span the concrete so no load will be transmitted to the new concrete masonry. Required materials for temporary crossings will be available at the site before the curb and gutter is placed construct crossovers as soon as practicable after the concrete is placed and finished.
- B. In lieu of the above temporary crossings, gaps to provide for the passage of traffic may be left in the curb and gutter or sidewalk, if permitted by the Engineer. Complete placement of concrete in gap areas after previously placed adjacent concrete has sufficiently cured to carry traffic.
- C. Replace concrete damaged by traffic or otherwise damaged prior to its acceptance at the expense of the Contractor in a manner satisfactory to the Engineer. Protect the concrete masonry against both public traffic and the traffic caused by the Contractor's own employees and agents.

- D. Protect the unhardened concrete against damage by rain. When rain is imminent, cover the unhardened concrete immediately with paper, plastic film or other suitable material, and planks or forms placed along slip-formed pavement edges.
- E. Cure concrete by the impervious coating method outlined in WisDOT Section 415. Curing compound will conform to WisDOT Section 415.
- F. Protect the concrete as specified in WisDOT Section 415, except that the Engineer may allow the Contractor to open sidewalks to pedestrian traffic after the concrete has developed sufficient strength to prevent damage to the surface.
- G. Protective Covering for Cold Weather Pours
 - 1. Protective covering materials will conform to WisDOT 415 except for the following temperature and thickness requirements.
 - 2. The protective covering may consist of 12 inches of straw between two layers of polyethylene, or an approved equivalent curing blanket, providing the same level of thermal protection. Monitor the surface temperature of the concrete at locations determined by the Engineer. Maintain a surface temperature of 55°F for an initial set period of 72 hours after placement. If Type III cement is substituted or cement content is increased 100 pounds per cubic yard from the normal specification, protection is required for 48 hours. At no time should the surface temperature exceed 120°F.
 - 3. Prevent freezing of the concrete until it has developed sufficient strength to open it to service. Remove and replace any concrete damaged by freezing or frost action during the first seven days following its placement at no cost to the Owner.
- H. Opening to Service
 - 1. Maintain moisture, temperature, and physical protection for concrete until it develops sufficient strength to open it to service.
 - 2. Open concrete surfaces to construction and public traffic no sooner than when the concrete attains a verified compressive strength of 3500 psi. Without compressive strength information, the Engineer may allow the contractor to open the affected structural masonry after the following minimum times as adjusted for concrete surface temperature.

3.03 APPLICATION EQUIVALENT CURING DAYS

- A. High early strength concrete – 4
- B. General purpose concrete, grade A – 5
- C. General purpose concrete, grades A-FA, A-S, A-T, A-IS, A-IP, and A-IT - 7
- D. The equivalent curing day is based on a daily average concrete surface temperature of 60°F. Calculate the daily average concrete surface temperature by taking the average of the high and low temperatures at the least favorable location of the affected concrete unit, as verified by the Engineer, for each day. If this daily average concrete surface temperature falls below 60°F, then equivalent curing days

accumulate at a reduced rate. Use the following guidelines to calculate equivalent curing days; for a daily average concrete surface temperature of:

1. 60°F or more; accumulate one equivalent curing day per calendar day.
2. 40°F to less than 60°F; accumulate 0.6 equivalent curing day per calendar day.
3. Less than 40°F; no curing credit is accumulated.

E. Opening Strength

1. Determine opening strength and provide the Engineer with the information required to verify that strength by one or a combination of the following methods:
 - a. Compressive strength testing of cylinders.
 - b. Maturity method.
2. The resulting opening strength, when the engineer verifies, will apply to concrete on the same project conforming to the following criteria:
 - a. Of the same mix design as the test location.
 - b. Cured under similar or more desirable conditions.
 - c. Placed on or before the test location.
3. If both direct compressive strength test results and maturity data are not available, the Engineer may estimate compressive strength based on test results of concrete of the same mix design placed adjacent to and under similar conditions on the same project.

F. Compressive Strength Testing of Cylinders

1. Submit the compressive strength test results to the Engineer for verification. Compute the opening strength as the average of compressive strength test results for 2 cylinders. If the strength of a cylinder is less than 90 percent of the required strength, the Engineer will reject the resulting average. Field cure cylinders under conditions similar to those prevailing for the structural masonry unit they represent.
2. Fabricate cylinders according to AASHTO T23 and test the cylinders according to AASHTO T22.

G. Maturity Method

1. Develop a strength/maturity relationship for each concrete mix design. Base that relationship on the strength of cylinders from concrete incorporated into the work. Submit the maturity data to the Engineer for approval before placing more concrete using that mix design. Develop a new strength/maturity relationship every time the mix changes or if Engineer verification cylinder strength varies more than 10 percent from the required opening strength when tested at the calibrated opening maturity.
2. Conform to WisDOT Construction Materials Manual Chapter 8 for strength/maturity relationship development, field verification of the resulting curves, and maturity testing. Use a default datum temperature of 32°F or use a mix-specific datum temperature determined according to Annex A1 of ASTM C1074. Develop data points for the strength/maturity relationship up to 120 percent of the required opening strength.

3. Place at least one sensor for each 2,000 square yards of concrete pavement and one sensor for each 100 cubic yards of concrete placed under non-pavement bid items. The resulting maturity, after engineer verification, will apply to concrete on the same project conforming to the following:
 - a. Of the same mix design as the test location.
 - b. Cured under conditions similar to or more favorable than that of the test location.
 - c. Placed on or before the time the test location was placed.
4. Each work week, provide a set of 3 verification cylinders to the Engineer for each strength/maturity field calibration curve currently in use on the project. The Engineer will designate the sampling location for these verification cylinders. Provide 2 cylinders for compressive strength testing and one with a data encrypted sensor embedded in its center for maturity evaluation. Cast and cure these cylinders on-site as the Engineer directs and conform to the requirements of ASTM C31 for field curing. Deliver the 2 compressive strength cylinders to the Engineer after attaining 50 percent of their opening maturity. Notify the Engineer promptly when the instrumented cylinder reaches the opening maturity so the Engineer can perform verification testing as closely as possible to that opening maturity level.

3.04 CURB AND GUTTER

A. Placing Concrete

1. The Contractor may, with the approval of the Engineer, elect to use a machine for placing, forming and consolidating curb and gutter. If a machine is used, the resulting curb and gutter will be of such quality as to equal or exceed that produced by formed methods. Machine placed concrete curb and gutter will be hand trowel finished before broom finishing.
2. Securely anchor concrete curb and gutter, unless constructed integrally with concrete pavement, to adjoining concrete pavement by placing specified tie bars when and as shown on the Plans.
3. Use driven tie bars to tie new concrete curb and gutter to old in-place concrete pavements. Do not use driven tie bars in lieu of cast in place tie bars in construction joints of pavement and curb and gutter placed under the Contract.
4. When concrete curb and gutter is placed adjacent to existing asphalt pavement, sawcut existing asphalt pavement a minimum of 1 foot from the proposed flag of the gutter.
5. Contraction joints may be formed by sawing or by forming an induced plane of weakness at least 2 inches in depth in the curb and gutter directly opposite all construction or contraction joints in abutting concrete pavement and at the required spacing in curb, gutter, or curb and gutter adjoining asphaltic pavement. Such spacing will be approximately 6 feet to approximately 10 feet in length, but never less than 5 feet, as directed by the Engineer. Curb end taper sections (typical length 3 feet) are not subject to the minimum 5 foot joint spacing requirement.
6. The depth of cut and equipment used in sawing will meet the approval of the Engineer. Complete sawing as soon as practicable after the concrete has set sufficiently to preclude raveling during the sawing and before any shrinkage cracking takes place in the concrete. If this method results in random cracking, the Contractor will be required to form an inducted plane of weakness.

7. Separators, if used, will be removed as soon as practicable after the concrete has been struck off, consolidated and set sufficiently to preserve the width and shape of the joint. Face forms, if used, may be removed for finishing curb face and fillets as soon as the concrete will retain its shape. Back forms may be removed after the concrete has been in place for six hours.

B. Finishing

1. Thoroughly trowel and brush the face surfaces of the curb and gutter. Round edges at the back edge of the curbs, the edge of the gutter adjacent to the pavement and edges adjacent to expansion joints or induced contraction joints with an edge of $\frac{1}{4}$ -inch radius, unless noted otherwise in the plans. Point with mortar any honeycombed areas occurring along forms on back of curbs or edges of gutters.

C. Expansion Joints

1. Place expansion joints in curb and gutter constructed adjacent to asphaltic surfacing. Locate joints at all locations where tangent and radial curb or curb and gutter meet, on each side of every inlet about 3 feet from the inlet but not closer than about 6 feet from another joint and on tangent sections at a maximum spacing of 295 feet and a minimum spacing of 6 feet.
2. When curb and gutter is constructed adjacent to or on portland cement concrete pavement constructed with expansion joints, place expansion joints in the curb and gutter to match the locations of the expansion joints in the pavements.
3. Set joints at right angles to the face and top of the curb and at right angles to the flow line and surface of gutters. The joint filler will be $\frac{3}{4}$ -inch wide.

3.05 SIDEWALK

- A. The foundation, forms, and reinforcement when required, will be checked and approved by the Engineer before the concrete is placed. Place concrete on a moist foundation, deposited to the required depth, and consolidated sufficiently to bring the mortar to the surface, after which it will be struck off and finished to a true and even surface. The final floating will be done with a wooden float. Before the mortar has set, the surface will be brushed or lightly broomed. Before the concrete is given the final surface finish, the surface of the walk will be checked with a 10 foot straightedge, and any areas which show a variation or departure from the testing edge of more than $\frac{1}{4}$ inch will be corrected by adding or removing concrete as necessary while the concrete is still plastic.
- B. Concrete sidewalks may be constructed with suitable, approved slip-form equipment when permitted by the Engineer. The wood floating may be omitted when a suitable finish is produced by the slip-form equipment.
- C. Curb ramps will be constructed at the locations and in accordance with the details and dimensions shown on the Plans.
- D. Reinforcement
 1. Where reinforcement is required, it will conform to and be placed in accordance with the details shown on the Plans.

E. Joints

1. For sidewalks of uniform width, construct transverse joints at right angles to the sidewalk centerline, and construct longitudinal joints parallel to the centerline, unless specified otherwise. For sidewalks of variable or tapering widths, make the transverse and longitudinal joints at right angles to each other; if possible, review joint layout in the field with the Engineer.
2. Use contraction joints to divide the sidewalk into sections.
3. Place 1/2-inch wide transverse expansion joint filler through the sidewalk at uniform intervals not greater than 96 feet apart.
4. Place 1/2-inch wide expansion joint filler between the sidewalk and back of abutting parallel curb or gutter; and place one-inch wide expansion joint filler between sidewalk and buildings or other rigid structures.
5. Place 1/2-inch wide expansion joint filler between sidewalk approaches and the back of curb or gutter or edge of pavement.
6. No joint may deviate more than 5 degrees from perpendicular to the surface of the finished. Ensure that joint axes do not deviate more than 1/2 inch from a straight line, or from the designated alignment at any point. If constructing the joints in sections, do not use offsets or concrete struts between adjacent units.
7. If constructing the sidewalk in partial width slabs, place transverse joints so they match the like joints in adjacent slabs. If widening existing sidewalks, place transverse joints in line with like joints in the existing sidewalk.
8. If possible, do not divide sidewalks into sections less than 3 feet, or greater than 12 feet in any dimension. Produce the unit areas by using metal slab division forms extending to the concrete's full depth, or by contraction joints, as specified below.
9. A contraction joint in sidewalk may consist of a slot or groove, at least one inch deep and 1/4 inch wide. Form them by inserting a metal parting strip in the concrete after striking off and consolidating, and while the concrete is still plastic. As soon as the concrete retains its shape, remove the parting strip and edge finish the joint.
10. The contractor may form contraction joints by cutting the concrete not less than 1/4 of the depth through with a pointed trowel or other suitable tool. Edge-finish the joint.
11. The contractor may saw sidewalk contraction joints at least one inch in depth and approximately 1/8 inch wide. Perform the sawing as soon as possible after the concrete sets sufficiently to prevent raveling during sawing and before shrinkage cracking occurs.
12. Extend the expansion joint filler to the concrete's full depth and make the top slightly below the finished surface of the sidewalk.
13. For sidewalk, consolidate the concrete thoroughly at expansion joint faces to fill the voids, and finish the surface smooth and true to grade. Also round sidewalk edges along forms, un-sawed joints, and metal slab division forms with a 1/2-inch radius edger. For all other work under this

section, use mechanical vibration at expansion joint faces to fill the voids, and finish the surface smooth and true to grade.

14. Do not seal joints.

F. Backfilling and Restoring the Site of the Work

1. Backfill spaces along the sides with satisfactory soil and thoroughly compact where the sidewalk does not abut curb, curb and gutter, pavement or other structures and when the concrete in such sidewalk has been cured and the forms removed. The backfill will conform to the section shown on the Plans. Dispose surplus excavation and restore the site of the work to a neat and orderly condition.

G. Steps

1. Build steps and landings, if required, at the locations and in accordance with the design, dimensions and details shown on the Plans. Include reinforcement and necessary excavation, backfilling and disposal of excess material from excavation. Formed surfaces of landings, risers and side of steps will receive a rubbed surface finish.

H. Driveways and Alleys

1. Longitudinal joints where shown on the Plans will be construction joints unless otherwise authorized. Place expansion joints where the driveway or alley abuts a pavement or sidewalk.

3.06 METHOD OF MEASUREMENT/BASIS OF PAYMENT

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.

B. Curb and Gutter

1. Measure curb and/or gutter, completed in accordance with the terms of the Contract, by length in feet along the base of the curb face or along the flow line of the gutter and such measurement will be continuous along such line extended across driveway and alley entrance returns or ramps. No deduction in length will be made for drainage structures installed in the curbing such as inlets, etc.
2. All excavation required for and performed during construction of curb, gutter, or curb and gutter, when covered by a bid item in the contract, will be measured for payment as provided in the specifications; however, when the contract does not provide a bid item for excavation, such work required and performed will not be measured for payment, but will be considered as subsidiary to and a part of the item of curb, gutter, or curb and gutter, as the case may be.
3. The quantity, if measured individually as provided above, will be paid for at the contract unit price per lineal foot for the items of concrete curb and/or gutter (size, type), as the case may be. Price is full compensation for all excavation and preparation of foundation and all special construction required at driveway and alley entrances or curb ramps; for furnishing all materials, including concrete masonry, expansion joints, and reinforcement tie bars unless otherwise

provided; for placing, finishing, protecting and curing; for sawing of joints; and for all labor, tools, equipment and incidentals necessary to complete the work, including disposal of surplus material from excavation and restoring the site of the work provided, however, that where the contract provides a bid item for excavation, such item of work required for construction of curb, gutter, or curb and gutter will be paid for as provided in the contract.

C. Sidewalk

1. Measure sidewalks including curb ramps and steps including landings, by area in square feet and the quantity measured for payment will be the amount actually completed and accepted in accordance with the terms of the Contract, computed from dimensions as shown on the Plans or as altered by direction of the Engineer.
2. In the case of steps including landings, the area measured for payment is the summation of the areas of the treads and landings, computed by multiplying the width of the tread and landing by the length of the tread and landing.
3. The area, if measured as provided above, will be paid for at the contract unit price per square feet for the items of concrete sidewalk including curb ramps, or concrete steps including landings, as the case may be, which price will be full compensation for furnishing all materials, including concrete masonry, reinforcement and expansion joints; for all excavation and preparation of foundation, backfilling and disposal of surplus material; for placing, finishing, protecting and curing; and for all labor, tools, equipment and incidentals necessary to complete the work and restore the site of the work provided, however, that when the contract provides a bid item for common excavation, such work required and performed in the construction of concrete sidewalks will be paid for as provided in the contract.

D. Drives and Alleys

1. Measure concrete driveways and concrete alleys by the area in square feet and the quantity to be paid for is the number of square feet of concrete driveway or alley completed and accepted.
2. Concrete driveways and concrete alleys will be paid for by the square feet, if measured as provided above, and will be paid for at the contract unit price per square feet for concrete drives, which price will be full compensation for furnishing, hauling, preparing, placing, curing and protecting of all materials, including cement, concrete masonry, joints and joint materials, dowels and tie bars, unless otherwise provided; for preparing foundation, unless otherwise provided; for filling core holes; and for all labor, equipment, tools and incidentals necessary for constructing the pavement complete, including reinforcement.

END OF SECTION 32 16 00

SECTION 32 17 23 PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section describes furnishing and applying, or removing, pavement markings. This specification follows the WisDOT Standard Specifications. For projects using this specification that do not involve WisDOT funding, certain testing requirements will not be required.
- B. This section also describes furnishing and applying, or removing, special pavement markings consisting of a combination of lines, arrows, symbols, and words and temporary pavement markings.

PART 2 - PRODUCTS

2.01 Materials

- A. Deliver paint and epoxy materials to the job site unopened, in manufacturer's containers legibly marked with the contents, color, batch number, date manufactured, and manufacturer's name and address. Do not use paint or epoxy more than 1 1/2 years after its date of manufacture.

2.2 Paint

- A. Furnish paint, glass beads, epoxy, or preformed markings in accordance with the WisDOT approved products list.

2.3 Removable Tape

- A. Furnish new tape with a pre-coated pressure-sensitive adhesive. Use tape that has demonstrated good performance in 6-month NTPEP tests for retroreflectivity, appearance, durability, removability, and residue. Use reflectorized tape where the plans show yellow or white marking.

2.4 Removable Mask-Out Tape

- A. Furnish non-reflective removable black mask-out tape from the department's approved products list. Upon removal, remove adhesive ensure that underlying marking is completely visible.

2.5 Raised Pavement Markers

- A. Furnish raised pavement markers for temporary pavement marking from the department's approved products list. Use the colors and configurations the plans show. If installing at a new location, use new markers. If installing replacement markers, the contractor may install used markers in like-new condition.

PART 3 - EXECUTION

3.01 Surface Preparation

- A. Prepare the surface receiving marking to promote a good bond. Use equipment with a dust control system. Remove dust, dirt, oil, grease, loose paint, gravel, debris, or other materials and contaminants

that might prevent bonding. Ensure that the surface is dry and free from frost, except the contractor may apply epoxy to damp pavement. Prepare concrete surfaces using brush-off blasting to remove curing compound, protective surface treatment on structures, and laitance. Conform to the "Steel Structure Painting Council Surface Preparation Specification Number 7" and expose at least 85 percent of the concrete receiving marking.

- B. After the marking can sustain exposure to traffic, re-apply clear protective surface treatment where it was removed from structures to prepare the surface for pavement marking. Seal exposed concrete, including grooves for tape, and over the pavement marking.
- C. Air blast or sweep milled asphaltic surfaces.
- D. Do not remove epoxy overlay materials in areas receiving pavement marking. Use only epoxy pavement marking where the contract requires marking placed on epoxy overlays.
- E. Apply pavement markings at the locations, and to the dimensions and tolerances the plans show, or as the engineer directs. Use the color the plans show.

3.02 General Marking Requirements

Under the Pavement Marking bid items, apply centerlines, no-passing barrier lines, lane lines, channelizing lines, edgelines, and other lines of the width the bid item indicates.

Apply markings at the locations and to the dimensions and tolerances the plans show, or as the engineer directs. Complete marking within specified time limits. Match the marking cycle at both project ends to be continuous from the existing marking to the new marking. Use the color the plans show. Ensure that lines have a uniform cross-section and color. Reflectorize the lines with glass beads distributed uniformly throughout the specified thickness. Provide a sharp cutoff on both sides and ends of the line. Do not damage existing pavement markings that will remain in place.

On contracts without the Locating No-Passing Zones bid item, reference the beginning and end of existing no-passing barrier lines before pavement resurfacing that covers the pavement markings. After completing the resurfacing, accurately re-mark the no-passing barrier lines.

Apply permanent edgeline markings to the upper layer of new asphaltic pavement or surfacing within 7 days after completing mainline paving, but before a scheduled work suspension, unless the contract requires or the engineer directs or allows otherwise.

Apply permanent pavement markings to new concrete pavements, or roads closed during construction, before opening those pavements to traffic, unless the engineer allows otherwise.

If removing existing markings before applying new markings, remove exposing at least 85 percent of the pavement surface. If installing new pavement marking without removing existing marking, retrace existing pavement markings or layout as the engineer directs.

On highways open to 2-way traffic, in addition to the marking vehicle, provide a leading vehicle and at least one trailing vehicle.

Protect freshly applied markings until the line is dry or cured enough to prevent pickup under traffic. Place traffic cones on wet lines immediately behind the marking train or use a convoy of moving vehicles to keep traffic from crossing the wet line. Remove cones promptly after the line dries or cures.

Under the Pavement Marking Railroad Crossings bid items, apply the RXR symbol and 3 transverse stripes the plans show. On contracts that do not include other pavement-marking work, also apply edgelines, lane lines, centerline, and no-passing barrier lines adjacent to the railroad crossing as the plans show.

Under the Pavement Marking Curb bid items, apply marking material to the vertical face and top of the curb.

3.03 Late Season Marking Requirements

- A. Do not place permanent pavement marking after November 15 and before April 15 of the following calendar year. Instead apply any marking material from the department's approved products list in the exact locations the plans show for permanent marking. Maintain that marking until April 15, then unless the engineer allows otherwise, completely remove and replace it with permanent pavement marking. From November 15 to April 15, evaluate the marking for required maintenance. Perform corrective maintenance whenever the failure rate exceeds 25 percent for any section of marking.

3.04 Applying Paint

- A. Apply paint as the manufacturer specifies. Do not apply below the minimum pavement temperature the manufacturer recommends. If the engineer requests, provide manufacturer specifications.
- B. Apply paint uniformly across the line at or exceeding a wet film thickness of 16 mils. For reflective paint, apply glass beads uniformly across the width of the line at a rate of 8 to 10 pounds per gallon of paint.
- C. Apply glass beads for symbols, words and crosswalks uniformly across the width of the line at or exceeding 18 pounds per gallon of paint or epoxy. Protect arrow, symbol, and word markings with cones, barricades, or vehicles until dry or cured to a no-pickup condition.

3.05 Applying Epoxy

- A. Apply epoxy as the manufacturer specifies. Do not apply below the minimum pavement temperature the manufacturer recommends. If the engineer requests, provide manufacturer specifications. For both concrete and asphalt surfaces, remove surface contaminants by sweeping, air jetting, or water blasting immediately before applying the epoxy. Do not apply epoxy over marking materials with less adherence than the epoxy. Prepare the surface to ensure a permanent bond.
- B. Delay application to new seal coated surfaces for at least 14 calendar days after applying seal coat.
- C. For the initial application, apply epoxy uniformly across the line at or exceeding a wet film thickness as follows:
 - 1. 25 mils for SMA pavement, seal coated surfaces, and epoxy overlay surfaces.
 - 2. 20 mils for asphalt or concrete rumble strip surfaces.
 - 3. 20 mils for tined or diamond ground concrete pavement surfaces.
 - 4. 15 mils for all other pavement surfaces.
- D. For subsequent applications, apply epoxy uniformly across the line at or exceeding a wet film thickness of 16 mils for all pavement surfaces.

3.06 Applying Preformed Markings

- A. Apply preformed markings as the manufacturer specifies. If the engineer requests, provide

manufacturer specifications. On asphalt, apply preformed plastic marking tape just before final rolling and roll the tape into the surface.

3.07 Proving Period

- A. The department will accept the work based on an inspection conducted when the contractor completes the work. The engineer will, however, conduct post-acceptance inspections periodically during a proving period to evaluate the performance of paint, epoxy, and preformed markings. The proving period begins on the last day of the month, for all marking placed within each calendar month. For paint, the proving period is 180 days. For epoxy and preformed markings, the proving period extends through April 15 of the next calendar year or 180 days, whichever is longer. If weather or road surface conditions prevent the engineer from fully evaluating the marking at the specified end of the proving period, the engineer may extend the proving period.
- B. Each special pavement marking including stop lines, crosswalks, railroad crossings, arrows, symbols, and words constitutes a separate section subject to the engineer's evaluation at the end of the proving period
- C. The engineer will determine the percent failing during the proving period. The engineer will exclude failures due to abrasion loss at private entrances or within intersections. The department defines failure as discoloration, chipping, substrate exposure, or inadequate reflectivity.
- D. Replace all marking in sections with more than 10 percent failing and repair or replace markings that the engineer deems improperly constructed.

3.08 Removing Pavement Markings

- A. Remove pavement markings from locations the plans show or as the engineer directs. Do not damage, discolor, leave a detrimental residue on the surface, or paint over existing markings. Provide a dust control system and remove accumulated sand or other materials. If blast cleaning within 10 feet of a lane open to public traffic, remove dust and other residue continuously while blast cleaning. Collect, haul, and dispose of dust or residue from removals. Repair damage caused by the contractor's removal operations including resealing the area of bridge deck surface damaged during pavement marking removal.

3.09 Temporary Pavement Markings

- A. Apply temporary pavement markings at the locations, and to the dimensions and tolerances the plans show, or as the engineer directs. Use removable tape for temporary marking placed on bridge decks. Use the color the plans show. If applying markings over markings of a different color, completely cover the original markings. If at any point a differently colored underlying marking shows through, re-apply the overlying marking.
- B. For pavements open to all traffic, apply centerline and no-passing barrier line markings as follows:
 - 1. On intermediate pavement layers, including milled surfaces, on the same day the pavement is placed or milled.
 - 2. On the upper layer of pavement, on the same day the pavement is placed unless the contractor applies permanent marking on the same day the pavement is placed. If weather conditions preclude same-day application, delineate the travel lanes, and provide no-passing signing as the

engineer directs. Apply centerlines and no-passing barrier lines as soon as conditions allow. The engineer may restrict operations until these markings are completed.

- C. Apply temporary paint or epoxy at a minimum wet film thickness of 12 mils. Reflecterize with 4 pounds of glass beads per gallon of paint or epoxy applied to the wet line immediately after painting. Apply paint or epoxy and glass beads at a uniform rate across the full width of the line.
- D. Apply temporary marking tape as the manufacturer recommends. Apply temporary raised markers using the surface preparation and installation procedures the manufacturer recommends.
- E. Remove Temporary Raised Pavement Markers and marking applied under the Temporary Pavement Marking Removable Tape bid items without damaging the pavement or bridge deck.

3.10 Measurement

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.
- B. For items measured by the linear foot of line, calculate quantities as follows:
 - 1. For solid lines; by adding the linear feet of solid line measured end to end.
 - 2. For intermittent lines; by multiplying the specified length of the individual markings of the line by the number of markings in the intermittent line end to end.
 - 3. Measure the Pavement Marking Yield Line Symbols bid items as each individual triangle in the yield line.
 - 4. Measure the linear foot bid items under this section by the linear foot of line acceptably completed.
 - 5. Measure the Pavement Marking Concrete Corrugated Median bid items by the square foot acceptably completed.
 - 6. Measure Removing Pavement Markings Arrows, Removing Pavement Markings Symbols, and Removing Pavement Markings Words as each individual arrow, symbol, or word acceptably removed. The department will count removing an RXR symbol as 3 individual symbol removals.
 - 7.

3.11 Payment

- A. Measured quantities at the contract unit price under the following bid items:

ITEM DESCRIPTION	UNIT
Pavement Marking (material) (width)	LF
Pavement Marking Same Day (material)	LF
Removing Pavement Markings	LF
Pavement Marking Railroad Crossings (material)	EACH
Pavement Marking Arrows (material) (type)	EACH
Pavement Marking Arrows Bike Lane (material)	EACH

Pavement Marking Symbols (material)	EACH
Pavement Marking Symbols Bike (type) (material)	EACH
Pavement Marking Words (material)	EACH
Pavement Marking Words Bike Lane (material)	EACH
Pavement Marking Curb (material)	LF
Pavement Marking Curb Ramp (material)	LF
Pavement Marking Yield Line Symbols (material) (height)	EACH
Pavement Marking Stop Line (material) (width)	LF
Pavement Marking Island Nose (material)	EACH
Pavement Marking Parking Stall (material)	LF
Pavement Marking Diagonal (material) (width)	LF
Pavement Marking Cross Walk (material) (width)	LF
Pavement Marking Aerial Enforcement Bars (material) (width)	LF
Pavement Marking Concrete Corrugated Median (material)	SF
Removing Pavement Marking Arrows	EACH
Removing Pavement Marking Symbols	EACH
Removing Pavement Marking Words	EACH
Temporary Pavement Marking Removable Tape 4-Inch	LF
Temporary Pavement Marking Removable Contrast Tape 4-Inch	LF
Temporary Pavement Marking Paint 4-Inch	LF
Temporary Pavement Marking Epoxy 4-Inch	LF
Temporary Pavement Marking Removable Mask-Out Tape 6-Inch	LF
Temporary Pavement Marking Removable Mask-Out Tape 10-Inch	LF
Temporary Pavement Marking Removable Tape 6-Inch	LF
Temporary Pavement Marking Removable Tape 8-Inch	LF
Temporary Pavement Marking Paint 8-Inch	LF
Temporary Pavement Marking Epoxy 8-Inch	LF
Temporary Pavement Marking Stop Line 12-Inch	LF
Temporary Pavement Marking Stop Line Removable Tape 12-Inch	LF
Temporary Pavement Marking Stop Line 18-Inch	LF
Temporary Pavement Marking Stop Line Removable Tape 18-Inch	LF
Temporary Pavement Marking Stop Line 24-Inch	LF
Temporary Pavement Marking Stop Line Removable Tape 24-Inch	LF
Temporary Pavement Marking Diagonal 12-Inch	LF
Temporary Pavement Marking Diagonal Removable Tape 12-Inch	LF
Temporary Pavement Marking Arrows Removable Tape	EACH
Temporary Pavement Marking Arrows Paint	EACH
Temporary Pavement Marking Arrows Epoxy	EACH
Temporary Pavement Marking Words Removable Tape	EACH
Temporary Pavement Marking Words Paint	EACH
Temporary Pavement Marking Words Epoxy	EACH
Temporary Raised Pavement Markers (type)	EACH

B. Payment for the Pavement Marking bid items under this section is full compensation for preparing the surface, including brush-off blasting of concrete; for providing marking, including reflectorization with glass beads; for protecting marking until dry or cured; for resealing areas of clear protective surface treatment on structures; and for replacing marking improperly constructed or that fails during the proving period. Payment for paint and epoxy items also includes remarking if initially applied at less than 90 percent of the specified rate.

C. Late season marking because of delays the Owner is not responsible for is incidental to the contract.

- D. Payment for the Pavement Marking bid items under this section also includes placing and removing temporary pavement marking placed under the contractor option of same-day pavement marking.
- E. For the Pavement Marking Epoxy bid items, the Owner will pay separately for engineer-directed removals under Removing Pavement Markings if removal is required to prepare the surface for the initial marking application. Removals required to replace defective markings are incidental to the Pavement Marking Epoxy bid items.
- F. Payment for Removing Pavement Markings is full compensation for removal; for repairing associated damage including resealing bridge decks; for dust collection; and for disposal of residue.

END OF SECTION 32 17 23

**SECTION 32 17 26
DETECTABLE WARNING FIELD**

PART 1 - GENERAL

1.01 SUMMARY

- A. This work consists of furnishing and installing a detectable warning field in concrete curb ramps, and other locations where sidewalks or trails intersect with traffic routes.

PART 2 - PRODUCTS

2.01 SUBMITTALS

- A. Prior to delivering the detectable warning fields, provide Engineer with a detailed description of the proposed warning field proposed.

2.2 MATERIALS

- A. Furnish materials conforming to the State of Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction, current edition (WisDOT Spec).
- B. Furnish inset cast iron detectable warning fields for curb ramps from the department's approved products list for the color defined in the Detectable Warning Field bid item. An acceptable alternative warning field may be used if constructed of stone, brick, and meeting the ADA requirements. Fiberglass or other synthetic cast products are not acceptable.

PART 3 - EXECUTION

3.01 GENERAL

- A. Construct curb ramps at the locations and conforming to the details and dimensions the plans show. Embed detectable warning fields in plastic concrete conforming to manufacturer-recommended procedures. Do not install on hardened concrete.

3.02 METHOD OF MEASUREMENT/BASIS OF PAYMENT

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.
- B. The department will measure Concrete Loading Zones; Concrete Safety Islands; and the Detectable Warning Field bid items by the square foot acceptably completed.

END OF SECTION 32 17 26

SECTION 33 05 13 MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY

- A. The work in this section consists of constructing manholes, special manholes, inlets, and castings as shown on the Plans.

1.02 SUBMITTALS

- A. Shop Drawings
 1. Submit four (4) copies of Shop Drawings to Engineer for review, in accordance with Section 013323. An alternative to submitting the paper copies is submitting the shop drawings in a portable document format (pdf) formatted to accept edits and mark ups. Include a cover letter or note in the submittal to the Engineer indicating that the contractor has reviewed the shop drawings for compliance with the project plans and specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Precast Reinforced Concrete Manholes
 1. Meet the requirements of ASTM C-478 for precast reinforced concrete manholes, risers, and tops. Use precast flat slabs or eccentric cone type for precast top sections. 48-inch diameter cone and barrel sections will be a minimum 5 inches thick. Concrete will have a minimum compressive strength of 4000 psi.
 2. Crown sanitary sewer manholes to a 27-inch opening as shown on the Plans. Start the cone a minimum of 15 inches below finished grade.
 3. Construct storm sewer manholes with a precast top slab with an opening required for casting, as shown on the Plans.
 4. Use tongue and groove joints with rubber-type gaskets. The rubber-type gaskets will meet the requirements of ASTM C-443.
 5. Use precast concrete manhole bases, field poured bases, or precast integral base-barrel sections as detailed on the plans. If the Plans do not specify type of base required, it will be at Contractor's option.
 6. Outside drops are required for all sanitary sewer pipe-to-manhole connections where the entering pipe invert is more than 24 inches above the spring line of the outgoing pipe. Construct outside drops in accordance with the details in the Plans.
 7. Manhole steps will be installed by the manhole manufacturer and be steel-reinforced plastic. Use manhole steps made with an approved plastic such as copolymer polypropylene that meet the requirements of ASTM 2146 Type II Grade 49108. Also use steel-reinforced plastic steps with

a deformed ½-inch diameter reinforcing bar that conforms to the requirements of ASTM A-615 Grade 60.

8. For manholes installed in groundwater or for use with sanitary sewer, use a watertight elastomer connection boot (PSX type of boot by Press-Seal, Inc or equal) cast into the precast manhole base. For connections to existing manholes, drill a core hole and install a modular elastomer sealing system installed to create a permanent hydrostatic seal (Link-Seal by GPT Industries or equal) between the pipe and the manhole wall.

B. Inlets

1. Use inlets 24 inches by 36 inches rectangular or 30-inch diameter round with precast base and precut holes for pipes as shown on the Plans.

C. Castings

1. Use all manhole and inlet castings that conform to the requirements of ASTM A-48 and that are be free of cracks, holes, swells, and cold shuts. Use new and furnished castings as indicated on the Plans.

D. Block Built Structures

1. Block built structures will only be allowed if stated in the special provisions or by the discretion of the engineer during the shop drawing review process.
2. Unless the plans or contract provides otherwise, place all block structures on a precast reinforced concrete slab subject to shop drawing review procedures. Construct the slab in a way such that a minimum of 6 inches extends beyond the outside of all manhole or inlet walls. Use flat top slabs that are also precast reinforced concrete and subject to shop drawing review procedures. The top slab must be equal in dimension and shape to the manhole or inlet, such that it does not extend beyond the outside of any wall.

E. Bedding

1. Where water and/or soft, spongy subsoil is encountered, set all manhole bases on a minimum of eight (8) inches of ¾-inch rock bedding. Rock bedding is incidental to the manhole cost.
2. In other areas, use the same bedding for manholes as the bedding for the pipe being installed.

F. Mortar

1. Mortar to be used for pipe/manhole connections, block built structures, and concrete adjusting rings will be a Type M masonry mortar of the following proportions: twelve parts masonry sand, 3 parts Portland cement, and one part hydrated lime.

G. Concrete

1. For concrete used for manhole and inlet inverts, use minimum requirements for Grade A concrete as defined in Section 501 of the State of Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction.

H. Geotextile Fabric

1. Geotextile fabric, Type DF, consists of either woven or non-woven synthetic filter fabric. Non-woven fabric may be needle punched, heat bonded, resin bonded, or combinations thereof. Minimum requirements for all fabric are:

Test Requirement	Test Method	Value*
Minimum grab tensile strength	ASTM D 4632	110 lb
Minimum puncture strength	ASTM D 4833	40 lb
Minimum apparent breaking elongation	ASTM D 4632	30%
Maximum apparent opening size	ASTM D 4751	300 μm
Minimum permittivity	ASTM D 4491	0.70 sec ⁻¹

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions

1. At the time of delivery, inspect all manhole sections, bases, rings, and castings for loss or damage in transit. Do not accept materials unless proper exceptions as to loss and/or damage are made on the receipt obtained from the carrier.
2. Reject all material found during the progress of the work to have cracks, flaws, or other defects and promptly remove and replace defective material.
3. Safely store all material furnished until it has been properly installed.
4. Unload manhole sections and accessories, unless contrary instructions are received, at the point of delivery, hauled to, and distributed at the site of the project. Handle materials with care to avoid damage.
5. Identify staging areas for delivery of materials prior to the construction phase, preferable at the preconstruction conference. Provided traffic control approved by jurisdictional authority for roadways for all delivery activities. Confirm jurisdictional authority with Engineer for routes designated as lettered county or numeric state or federal highways.

3.02 ERECTION/INSTALLATION/APPLICATION

A. Manhole Bases

1. Set integral precast base and barrel sections plumb and at an elevation which allows a minimum of 2½ inches between the top of the base and the bottom of the outgoing pipe to allow for the field poured concrete manhole floor and invert. This 2½ inch gap is not required if manhole invert and flow line are precast by supplier.
2. For cast-in place concrete bases, set the precast bottom barrel section on concrete brick or block so that the bottom of the section is below the invert of the outlet pipe. The bottom barrel section will be plumb and a minimum 12 inches tall, with poured concrete base. Extend the cast-in-place base a minimum of 6 inches beyond the outside face of the barrel wall.

B. Pipe/Manhole Connection

1. Use masonry mortar in conjunction with manhole brick to fill the void between the pipe and manhole wall. Fill all voids to create a watertight seal. Apply a plaster coat of mortar to provide a smooth, even finish between the pipe and manhole wall.
2. Backfill the annular space between the manhole excavation and the outside of the manhole wall with bedding material up to the spring line of the connected pipes. Use concrete brick or block necessary between the manhole and first pipe joint to provide support for the pipelines.

C. Invert

1. Do not cast-in-place the invert until the manhole is completely built and backfilled. Form the invert flow line to be the same diameter as the largest connecting pipe.
2. For precast bases with precast flow lines, form the flow line to match the largest connecting pipe diameter. In cast-in-place and precast bases, construct the concrete floor in the manhole bottom to the spring line of the pipe and sloped upward to the manhole wall.
3. Cast inverts and finish to allow room for installation of the mandrel/dummy necessary to test deflection of flexible pipelines.

D. Riser and Cone Sections

1. Install riser and cone manhole sections plumb with steps aligned and located so as to allow direct access to the concrete landing created by the poured invert. Plug all lifting holes with non-shrink grout.

E. Casting and Rings

1. Center castings for manholes and inlets and brought to grade by use of adjusting rings (6-inch minimum/12-inch maximum). Use reinforced concrete adjusting rings, unless otherwise specified. Set concrete adjusting rings and grout in a (Type M) mortar bed. Cast-in-place a concrete collar around the exterior of the adjusting rings on all inlets. Grout and trowel finish the inner face of all concrete adjusting rings (with the same mortar).
2. Recycled HDPE adjusting rings may be used for manholes and/or inlets if provided for in the Special Provisions. Provide HDPE rings in varied thicknesses and tapered thicknesses as required, manufactured from recycled polyethylene plastic in accordance with ASTM D 1248, and install per manufacturer's recommendations. Place a bead of manufacturer-recommended butyl sealant between the rings, cone, and casting. If the cone or top slab is chipped or broken prior to placement of sealant and bottom ring, create a flat sealable surface using Type M mortar. Use a double bead of sealant between the casting and the top ring.
3. Wrap HDPE rings in geotextile fabric, Type DF. Extend the fabric a minimum of 6 inches onto the concrete structure for inlets, and 6 inches out from the lowest ring on manholes with a flat top slab. Extend the fabric onto the flange of the casting. Overlap any joints in the fabric a minimum of 12 inches. On inlets, the cast-in-place a concrete collar integral with the curb shall cover the adjusting rings and be at least 6 inches thick as measured outward perpendicular to the exterior walls of the inlet.

F. Casting Adjustment

1. Set castings in roadways to 1/4-inch (0.02 foot) to 3/8-inch (0.03125 foot) below finished asphalt surface. Set castings to match the cross slope and grade of the roadway surface. Use tapered adjusting rings if necessary to achieve the slope. Owner/Engineer may reject any casting adjustments outside this tolerance.

3.03 METHOD OF MEASUREMENT/BASIS OF PAYMENT

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.
- B. The quantity of manholes, structures and castings installed will be paid for at the Contract unit prices. When the quantity of manholes and structures installed will be paid for per vertical foot, they will be measured from the invert of the outgoing pipe to the rim or grate of the casting. The quantity of castings, per type, installed will be paid for at the contract unit price per each if listed on the bid form. Adjusting rings and sealant/mortar will not be paid for separately, but are considered incidental to the manhole or inlet items. Contract unit prices will be payment in full for furnishing all materials; forming foundation; sheeting and shoring; dewatering; backfilling; bedding material; removing sheeting and shoring; cleaning and restoring the site of the work; and for all labor, tools, equipment and incidentals necessary to complete the work in accordance with the Contract, unless specific Contract items are otherwise provided in the Contract.

END OF SECTION 33 05 13

**SECTION 33 40 00
STORMWATER UTILITIES**

PART 1 - GENERAL

1.01 SUMMARY

- A. The work in this section consists of constructing storm sewer, culvert pipes, and endwalls.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Use new undamaged material complying with and manufactured in conformity with the latest standards and/or specifications issued by AWWA, ASTM, ASA, AASHTO and FHWA.

- B. Reinforced Concrete Pipe (Circular)

- 1. For circular reinforced concrete pipe, use bell and spigot pipe made in accordance with ASTM C-76. Install pipe by open cut methods at minimum Class III, concrete strength equal to 4000 psi (or as otherwise indicated in the Plans). Pipe must be true and free from spalls or other defects and smooth enough that rubber jointing gaskets may be properly applied thereto. The inside slope of the bell or groove and the outside slope of the spigot or tongue where the gasket is positioned must be parallel; and the slope in the range of four to ten (4 to 10) degrees inclusive from the centerline axis of the barrel of the pipe. Pipe end planes are perpendicular to the longitudinal axis and not vary more than specified in ASTM C-76.
- 2. Clearly mark on each section of pipe the pipe class, date pipe was made, name of manufacturer, and, if applicable, the minor axis of elliptical reinforcing.
- 3. Use joints made with flexible compression-type rubber gaskets manufactured in accordance with ASTM C-361.

- C. Corrugated High Density Polyethylene (HDPE) Pipe

- 1. Corrugated HDPE pipe and fittings conforms to the requirements of the specifications for corrugated polyethylene pipe, 12- to 36-inch diameter (AASHTO M294, Type S). Corrugated HDPE pipe is N-12 as manufactured by Advanced Drainage Systems, or approved equivalent.
- 2. Minimum parallel plate pipe stiffness values are as follows:

Diameter	Pipe Stiffness*
12"	50 psi
15"	42 psi
18"	40 psi
24"	34 psi
36"	22 psi

* Per ASTM D-2412

- 3. The nominal size for the pipe and fittings is based on the nominal inside diameter of the pipe. Corrugated fittings may be either molded or fabricated by the manufacturer. Fittings supplied by

manufacturers other than the supplier of the pipe are not permitted without the approval of the Engineer.

4. Use joints that are soil tight push on type (bell and spigot) joints for storm sewer installations.
5. Install in accordance with ASTM D-2321 or as specified by the Engineer.
6. Furnish a manufacturer's certification that the product was manufactured, tested, and supplied in accordance with this Specification to the Engineer upon request.

D. Corrugated Metal Culvert Pipe (CMP)

1. Corrugated metal culvert pipe for standard installations will conform to AASHTO M36 and be 2 2/3 inches by 1/2 inch galvanized corrugated steel pipe with a minimum 16 gauge for 12 to 24 inches diameter pipes and 14 gauge for 30 to 36 inch diameter pipes, unless otherwise indicated in the Plans or Specifications.
2. Excessive fill heights may necessitate heavier gauge or different corrugation dimensions. Corrosive soils may necessitate the use of aluminized corrugated steel pipe or corrugated aluminum pipe. List special CMP project requirements in the plans or special provisions.
3. Use apron endwalls compatible in material and connection detail with the culvert pipe.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION

- A. Install all pipe to the required lines and grades shown on the Plans.
- B. Begin laying sewer pipe at the lowest point in the proposed sewer line. Install with the bell end of bell and spigot pipe or with the receiving groove end of tongue and groove pipe pointing upgrade. Complete pipe bedding, haunching, initial backfill and final backfill in accordance with Section 330500 Common Work Installation and Testing Piping Systems.
- C. Grout solid concrete tapered plugs into lifting holes of RCP sections before initial backfill has been installed.
- D. The manhole connection of pipe sewers are accomplished by one of the following methods:
 1. When rigid pipe is connected to a concrete brick, block, or precast manhole within the manhole base, use support by block or brick.
 2. Where the pipe enters the manhole above the manhole base, use support from the wall of the manhole back to the face of the first pipe joint bell with a wall of backfill concrete, brick, or solid concrete block columns.
 3. Neatly brick or concrete to pipe into the manhole wall and coat the surface of the masonry work with a minimum of 1/4 inch mortar and rub the surface smooth.
- E. Install reinforced concrete aprons on the ends of corrugated polyethylene storm sewer pipe if endwalls are indicated in the plans. Fit corrugated PE pipe into bell of reinforced concrete apron.
- F. Install galvanized trash guards on aprons only where indicated in the Plans.

- G. Install joint ties for at least the last three joints for concrete pipe placed. If an apron endwall is used, tie the apron endwall joint and two additional pipe joints at each location. Joint ties are incidental to the pipe.
- H. Use tracer wire for non-conductive storm sewer pipes (including service connections and private mains) unless the storm sewer has manholes, aprons or clean outs as a means of locating the underground pipe. Tracer wire will be brown for storm sewer.

3.02 METHOD OF MEASUREMENT/BASIS OF PAYMENT

- A. If a unit price bid item is used for the item of work or if payment for the effort is itemized in some other manner by the contract, measure work in accordance with the applicable bid items. If no specific bid items are listed for items listed herein, all work is considered incidental to the project and disregard further provisions of this section.
- B. The quantity of storm sewer pipe installed will be paid for at the contract unit price per linear foot in place and passing required tests. The quantity of apron endwalls installed will be paid for at the contract unit price per each. Do not include the length of the apron endwall in the length measured for pipe. No deduction from the measured length of pipe for intermediate drainage structures, junctions or fittings (except apron endwalls). The price paid is payment in full for furnishing all materials; forming foundation; sheeting and shoring; dewatering; laying pipe; sealing joints and making connections to new or existing fixtures; testing pipe; for backfilling; for furnishing granular bedding/haunching material; removing sheeting and shoring; cleaning and restoring the site of the work; and for all labor, tools, equipment and incidentals necessary to complete the work in accordance with the Contract, unless specific contract items are otherwise provided in the Contract.

END OF SECTION 33 40 00

SECTION 34 71 13 VEHICLE BARRIERS - TRAFFIC CONTROL

PART 1 - GENERAL

1.01 SUMMARY

- A. Many projects include work that will involve Contractor operations to take place near or on existing roadway, pedestrian, or other trail systems. When the work is located near or on such a system, install and maintain a system of traffic control devices that will allow for the safe and efficient flow of traffic either through the work zone, or around the work zone on approved alternative routes.

- B. All signing, barriers, lights and other devices used by the Contractor will be in accordance with the latest revision of Part VI, Temporary Traffic Control of the Federal Highway Administration's Manual on Uniform Traffic Control Devices (MUTCD), current edition and the Wisconsin Supplement to the MUTCD. The latest edition of FHWA's MUTCD can be found on the web at www.mutcd.fhwa.dot.gov; the Wisconsin Supplement can be found at WisDOT website by typing "WMUTCD" into the search box at the web site entry page.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The materials used for the traffic control devices will conform to the requirements specified in the Manual on Uniform Traffic Control Devices and the following:
 - 1. Use Type H reflective sheeting that complies with the following requirements for all signs, drums, barricades, and posts.

Specifications:	ASTM D4956-93b
Type:	III
Class:	1
Reflectivity:	2
Durability:	2200 hours (except orange and reboundable sheeting) 500 hours (orange and reboundable sheeting)
Color:	As specified in ASTM D 4956-93b

 - 2. Use traffic control drums made of non-metallic material and fabricated to accept a Type C (steady burn-low intensity) or a Type A (Flashing-low intensity) light. Each drum has a weighted base system that is designed to minimize hazardous conditions, if the drum is impacted during a crash condition.

 - 3. Use signs with reflective fluorescent orange prismatic sheeting.

PART 3 - EXECUTION

3.01 GENERAL

- A. Notify all utilities, local street departments, and all local emergency departments a minimum of 24 hours before closing any street. Coordinate all closures with area residents and businesses along the closed section of project.

- B. Manage traffic by one of four possible ways. If a specific method is not indicated on traffic control plans for the project, present the selected method to the Engineer for acceptance and if deemed necessary by the Engineer, modified to meet the requirements of the Owner. If a traffic control plan is prepared as part of the Contract documents, complete the traffic control work in accordance with the Plans. The four options are as follows:
1. Option 1: No Traffic Control Required. The Contractor's work will not affect the traffic flow on any public street, trail, or sidewalk.
 2. Option 2: Temporary Work Zone Traffic Control. This method of control is utilized when the Contractor's operations are temporary in nature (e.g. paving, short term work one day or less). Place advance warning and on-site signs as necessary to inform the traveling public of the work in accordance with the traffic control plans, if provided.
 3. Option 3: Long Term Traffic Control. This method of control involves the placement of traffic control devices that alter the flow of traffic through a work zone for a time exceeding a one-day period (all traffic control placed over night is considered long term). Complete the placement of the devices in a manner and method that will allow for the devices to resist the forces of nature for the duration of the project. Place signs on posts buried to a sufficient depth to resist tipping, or place on barricades when appropriate. Anchor barricades with sand bags.
 4. Engineer will approve the placement of all devices. If the Plans include a Traffic Control Plan, the placement of all traffic control must follow the Plan(s). If no traffic control plans are provided, provide the Engineer with a traffic control plan for review. The plan includes all phases of the work.
 5. Option 4: Road Closed Control. This method includes all necessary signs and barricades to close the road, trail, or sidewalk from the traveling public. Unless otherwise stipulated in the Contract documents, complete the work in a manner that will be the least disruptive to the business, industry, or residential facilities located within the limits of the work zone. Provide for a temporary drive surface, ramps at project ends and driveways, and other accommodations to allow adjacent facilities access during the course of construction. Such facilities may be closed during daytime operations in order to facilitate productive construction work. Prior to all road closures, provide contact to each adjacent facility with an explanation of the temporary accommodations that will be provided and the hours they will be available. Provide documentation of the contacts to the Engineer. Make contacts no less than three days prior to the work and associated closure for residential parcels, and 7 days for commercial and industrial facilities.
- C. Traffic Control Detour
1. Traffic control detour includes all work necessary to sign the designated detour route as shown on the Plans or as directed by the Engineer. Traffic control detour includes, but is not limited to, flagging and guiding traffic, covering and uncovering signs.
- D. Traffic Control Maintenance
1. Inspect and maintain all traffic control signs and devices including detour routes daily. If the Contractor has not provided proper maintenance for Traffic Control according to Specifications and Plans, the Engineer may restrict construction operations affected by defective traffic control until improvements are made.

2. Cover or temporarily remove existing signs that are in conflict with approved traffic control plans. Covering is allowed if the maximum traffic control will be in place a maximum of 7 calendar days.

3.02 METHOD OF MEASUREMENT/BASIS OF PAYMENT

- A. The method of measurement and basis of payment for traffic control work will be by the day, lump sum, or if no traffic control bid items, incidental to the project. If the Bid Form indicates days, each device (arrow boards, drums, barricades, lights, and signs) will be measured as days, which is the number of calendar days the device is in service. Any day in which the device is out of service for more than two hours when it is required for use, will result in one day being deducted from the quantity measured for payment. If the bid item(s) are based on lump sum, all work associated with the traffic control will be paid under the lump sum item.
- B. The price paid will be for all work necessary for constructing, assembling, covering existing signs, painting, hauling, erecting, re-erecting, maintaining, and removing traffic control devices.

END OF SECTION 34 77 13